Lloyd's Register

Rules and Regulations for the Classification of Naval Ships, January 2010

Notice No. 3

Effective Date of Latest Amendments:

See page 1

Issue date: August 2010

RULES AND REGULATIONS FOR THE CLASSIFICATION OF NAVAL SHIPS, *January 2010*

Notice No. 3

This Notice contains amendments within the following Sections of the *Rules and Regulations for the Classification of Naval Ships, January 2010.* The amendments are effective on the dates shown:

Volume	***Part***	***Chapter***	***Section***	***Effective date***
1	1	2	3	1 January 2011
1	1	3	2,15	1 January 2011
1	3	5	8	1 January 2011
2	1	2	3,4,5,6,16	1 January 2011
2	2	1	2,6,9,15	1 January 2011
2	2	2	7	1 January 2011
2	3	1	5	1 January 2011
2	3	2	4	1 January 2011
2	4	4	2,8	1 January 2011
2	5	1	2	1 January 2011
2	7	1	2,4,6,7,8,9,11,18	1 January 2011
2	7	2	3,7,10,	1 January 2011
2	7	3	5,6,9	1 January 2011
2	7	4	1	1 January 2011
2	7	5	1	1 January 2011
2	8	1	1,15,18	1 January 2011
2	9	1	1	1 January 2011
2	10	1	1,3,5,6,7,9,10,11,13,14	1 January 2011
2	11	1	1	1 January 2011
2	11	2	1	1 January 2011
2	11	3	1	1 January 2011
3	1	3	1-7	1 January 2011
3	1	4	1-6	1 January 2011
3	1	5	1-3,5	1 January 2011
3	3	2	8	1 January 2011

It will be noted that the amendments also include corrigenda, which are effective from the date of this Notice.

The *Rules and Regulations for the Classification of Naval Ships, January 2010* are to be read in conjunction with this Notice No. 3. The status of the Rules is now:

Rules for Naval Ships	Effective date:	January 2010
Notice No. 1	Effective date:	1 March 2010 & Corrigenda
Notice No. 2	Effective date:	1 January 2011
Notice No. 3	Effective date:	1 January 2011

Volume 1, Part 1, Chapter 2
Classification Regulations

Effective date 1 January 2011

■ *Section 3*
Character of Classification and Class notations

3.7 Military Distinction notations

Table 2.3.2 Machinery Class Notations

Machinery Notations *See* 3.8		
✠ LMC Propulsion and essential machinery **✠ LMC** Propulsion and essential machinery **[✠] LMC** Propulsion and essential machinery **LMC** Propulsion and essential machinery **MCH** Propulsion and essential machinery **SCM** Screwshaft Condition Monitoring **TCM** Turbine Condition Monitoring **PMR** Propulsion System Redundancy **PMR*** Propulsion System Redundancy in Separate Compartments **SMR** Steering System Redundancy **SMR*** Steering System Redundancy in Separate Compartments **PSMR** Propulsion and Steering System Redundancy **PSMR*** Propulsion and Steering System Redundancy in Separate Compartments **L** Additional character to **SMR**, **PMR**, **PSMR** and * notations for limited capability **ELS** Quality of electrical power supplies	**AG1** Enhanced analysis of propulsion and/or auxiliary gear elements **AG2** Enhanced three dimensional finite element analysis of propulsion and/or auxiliary gear elements **AP1** Enhanced assessment of propeller manufacturing tolerances on fast ships and craft **AP2** Enhanced assessment of propeller manufacturing tolerances having reduced noise characteristics **MPMS** Machinery Planned Maintenance Scheme **MCM** Machinery Planned Maintenance Scheme with Condition Monitoring **RCM** Machinery Planned Maintenance Scheme with Reliability Centred Maintenance **RAS(ABV)** Replenishment at Sea, Astern, Abeam and VERTREP **RAS(AB)** Replenishment at Sea, Abeam and Astern **RAS(AV)** Replenishment at Sea, Astern and VERTREP **RAS(BV)** Replenishment at Sea, Abeam and VERTREP **RAS(A)** Replenishment at Sea, Astern	**RAS(B)** Replenishment at Sea, Abeam **RAS(V)** Replenishment at Sea, VERTREP **(NT)** Additional to **RAS( )**, NATO requirements **UMS** Unattended Machinery Spaces **CCS** Centralised Control Station **ICC** Integrated Computer Control **IP** Integrated Propulsion ~~**DP(CM)**~~ ~~Dynamic Positioning (Centralised Remote Manual Controls)~~ ~~**DP(AM)**~~ ~~Dynamic Positioning (Automatic main and manual standby controls)~~ ~~**DP(AA)**~~ ~~Dynamic Positioning (Automatic main and automatic standby controls)~~ ~~**DP(AAA)**~~ ~~Dynamic Positioning (Automatic main and automatic standby controls with additional /emergency automatic control)~~ ~~**NAV1**~~ ~~Navigation equipment~~ **IBS** Integrated Bridge System **PRM** Provision Refrigeration Machinery

3.8 Machinery and Engineering Systems notations

3.8.3 The following class notations are associated with dynamic positioning arrangements, and may be assigned.

DP(CM) This notation may be assigned when a ship is fitted with centralised remote manual controls for position keeping and with position reference system(s) and environmental sensor(s). It denotes that the control engineering equipment has been arranged, installed and tested in accordance with LR's Rules, or is equivalent thereto.

DP(AM) This notation may be assigned when a ship is fitted with automatic main and manual standby controls for position keeping and with position reference system(s) and environmental sensor(s). It denotes that the machinery and control engineering equipment has been arranged, installed and tested in accordance with LR's Rules, or is equivalent thereto.

DP(AA) This notation may be assigned when a ship is fitted with automatic main and automatic standby controls for position keeping and with position reference system(s) and environmental sensor(s). It denotes that the machinery and control engineering equipment has been arranged, installed and tested in accordance with LR's Rules, or is equivalent thereto.

DP(AAA) This notation may be assigned when a ship is fitted with automatic main and automatic standby controls for position keeping together with an additional/emergency automatic control unit located in a separate compartment and with position reference systems and environmental sensors. It denotes that the machinery and control engineering equipment has been arranged, installed and tested in accordance with LR's Rules, or is equivalent thereto.

PCR The class notation will be supplemented with a Performance Capability Rating (PCR). This rating indicates the calculated percentage of time that a ship is capable of holding heading and position under a standard set of environmental conditions (North Sea).

3.8.4 The following class notations are associated with navigation safety, and may be assigned:

NAV1 This notation will be assigned when the bridge layout and level of equipment are such that the ship is considered suitable for safe periodic operation under the supervision of a single watchkeeper on the bridge. It denotes that the navigational installation has been arranged, installed and tested in accordance with LR's Rules, or is equivalent thereto.

IBS This notation will be assigned where an integrated bridge system is fitted to provide electronic chart display, track planning and automatic track following, centralised navigation information display, and bridge alarm management. It denotes that the integrated bridge system has been arranged, installed and tested in accordance with LR's Rules, or is equivalent thereto. For assignment of this notation, in addition to satisfying LR Rules, or equivalent thereto, for navigational function integration:

(a) the layout of the bridge and the equipment located on the bridge is to satisfy the requirements of a relevant Naval, International or National ergonomic or human-centred design standard, or an acceptable equivalent, to the satisfaction of LR; or

(b) the notation NAV1 is also to be assigned; or

(c) where the bridge is not intended to operate a periodic one man watch, the layout of the bridge and the equipment on the bridge are to satisfy the requirements for the assignment of the notation NAV1 to the satisfaction of LR with the exception of requirements identified by LR Rules that may be relaxed in such cases

Existing paragraphs 3.8.5 *and* 3.8.6 *are to be renumbered* 3.8.3 *and* 3.8.4.

Volume 1, Part 1, Chapter 3
Periodic Survey Regulations

Effective date 1 January 2011

■ *Section 2*
Annual Surveys – Hull, machinery and optional requirements

2.3 Machinery

2.3.13 For ~~ships fitted with automation equipment for~~ main propulsion, essential auxiliary and emergency machinery control engineering systems, a general examination of the equipment and arrangements is to be carried out. ~~Records of changes to the hardware and software used for control and monitoring systems for propelling and essential auxiliary machinery since the original issue (and their identification) are to be reviewed by the attending Surveyor~~ Records of modifications are to be made available for review by the attending Surveyor. The documentation required by Vol 2, Pt 9, Ch 1, including configuration management, is to be reviewed following system modifications to confirm compliance with applicable Rules. Satisfactory operation of the safety devices and control systems is to be verified. For ships having **UMS** or **CCS** notation, a general examination of the control engineering equipment required for these notations is also to be carried out.

2.3.16 ~~For ships assigned with **NAV1** and/or **IBS** class notations, Annual Surveys are to be carried out in accordance with the approved test schedule as required by Vol 3, Pt 1, Ch 4,1.2.1 to ascertain that the equipment and arrangements required for the applicable class notation(s) are being maintained in good working order. At the time of the survey, relevant statutory or Naval Authority Certificates may be accepted as evidence of satisfactory operation.~~

Existing paragraphs 2.3.17 *and* 2.3.18 *are to be renumbered* 2.3.16 *and* 2.3.17.

■ *Section 15*
Machinery planned maintenance and condition monitoring, MPMS, MCM and RCM

15.5 Conditions of operation

15.5.1 It is a condition of the Scheme that the Navy arranges for LR Surveyors to carry out an Annual audit of the machinery maintenance and monitoring records. Annual audits are to be held within three months before or after the due date and it is recommended that they are harmonised with the ship's Annual Survey.

(*Part only shown*)

15.5.2 Marine Engineer Officers may carry out surveys of all the machinery items for which they are authorised, at sea or in port, whichever is the most convenient. The following machinery items remain to be dealt with by an LR Surveyor, unless special arrangements have been agreed with the Navy:

- Sea connections.
- Machinery controls and controls associated with Class Notations, e.g. **UMS**, **CCS**, **ICC**~~,~~ and **IP** ~~and **DP**~~.
- Engine Trial.
- First start arrangement trial.

Volume 1, Part 3, Chapter 5
Anchoring, Mooring, Towing, Berthing, Launching, Recovery and Docking

Effective date 1 January 2011

■ *Section 8*
Windlass and capstan design and testing

8.2 ~~Performance~~ Windlass design

(*Part only shown*)

8.2.1 The following performance criteria are to be used as a design basis for the windlass:

(a) The windlass is to have sufficient power to exert a continuous duty pull over a period of 30 minutes of:

(i) For specified design anchorage depths up to 82,5 m:

Cable grade	Duty pull, P, in N
U1	~~$36{,}79d_e^2$~~ $37{,}5d_c^2$
U2	~~$41{,}68d_e^2$~~ $42{,}5d_c^2$
U3	~~$46{,}60d_e^2$~~ $47{,}5d_c^2$

(ii) For specified design anchorage depths greater than 82,5 m:

$P_1 = P + (D_a - 82{,}5)$ ~~0,214~~ $0{,}27d_c^2$ N

8.2.5 Calculations for torque transmitting components are to be based on 1500 hours of operation with a nominal load spectrum factor of 1,0. Alternatively unlimited hours with a nominal load spectrum factor of 0,8 can be applied.

8.2.6 Where the available input torque exceeds the torque required for anchor breakout then torque overload protection is to be fitted.

8.2.7 An arrangement to release the anchor and chain in the event of windlass power failure is to be provided.

8.2.8 The maximum stress from load cases stated in Table 5.8.2 is not to exceed the limits stated in Table 5.8.3.

Table 5.8.2 Design load cases for windlass and chainstopper

Load case	Condition	Note
1	Continuous pull	*See* 8.2.1(a)
2	Overload pull	*See* 8.2.1(b)
3	Brake holding load	*See* 8.2.1(c)

Table 5.8.3 Permissible stress for design load cases

Stress	Load case	
	1 and 2	3
	Permissible stress	
Tension	0,8Y	0,9Y
Compression or bending	0,8Y	0,9Y
Shear	0,7Y	0,7Y
Combined	0,85Y	0,9Y

NOTES

1. Where a component is subjected to axial tensile, axial compressive, bending or shear stress, F_c is to be calculated in the normal manner.
2. Where a component is subjected to a combination of co-existent stresses, F_c is the combined stress which is to be calculated as follows:

Combined bending and tension

$$F_c = 1{,}25f_c + f_{bt}$$

Combined bending and compression

$$F_c = f_c + f_{bc}$$

Combined bending, tension and shear

$$F_c = \sqrt{(1{,}25\, f_t + f_{bt})^2 + 3f_q^2}$$

Combined bending, compression and shear

$$F_c = \sqrt{(f_c + f_{bc})^2 + 3f_q^2}$$

where

F_c is the calculated stress
f_t is the calculated axial tensile stress
f_c is the calculated axial compressive stress
f_{bt} is the calculated maximum tensile stress due to bending about both principal axes
f_{bc} is the calculated maximum compressive stress due to bending about both principal axes
f_q is the calculated shear stress
Y is the specified 0,2 per cent proof stress for the material

8.2.9 The following criteria are to be used for gearing design:

(a) Torque is to be based on the performance criteria specified in 8.2.1.

(b) The use of an equivalent torque, T_{eq}, for dynamic strength calculations is acceptable but the derivation is to be submitted to LR for consideration.

(c) The application factor for dynamic strength calculation, K_A, is to be 1,15.

(d) Calculations are to be based on 1500 hours of operation.

(e) The static torque is to be 1,5 x T_n where T_n is the nominal torque.

(f) The minimum factors of safety for load capacity of spur and helical gears, as derived using ISO 6336 or a relevant National or International Standard acceptable to LR, are to be 1,5 for bending stress and 0,6 for contact stress.

8.2.10 Keyways are to be designed to a relevant National or International Standard acceptable to LR.

8.2.11 The maximum stress in brake components is not to exceed the permissible stress stated in Table 5.8.3.

8.3 Control arrangements

8.3.1 All control devices are to be capable of being controlled from readily accessible positions and protected against unintentional operation.

8.3.2 The maximum travel of the levers is not to exceed 600 mm if movable in one direction only, or 300 mm to either side from a central position if movable in both directions.

8.3.3 Wherever practical, the lever is to move in the direction of the intended movement. If this cannot be achieved, it is to move towards the right when hauling and towards the left when paying out.

8.3.4 For lever-operated brakes, the brake is to engage when the lever is pulled and disengage when the lever is pushed. The physical effort on the brake for the operator is not to exceed 160 N.

8.3.5 For pedal-operated brakes, the maximum travel is not to exceed 250 mm and the physical effort for the operator is not to exceed 320 N.

8.3.6 The handwheel or crankhandle is to actuate the brake when turned clockwise and release it when turned counterclockwise. The physical effort for the operator is not to exceed 250 N for speed regulation and 500 N at any moment.

8.3.7 When not provided with automatic sequential control, separate push-buttons are to be provided for each direction of operation.

8.3.8 The push-buttons are to actuate the machinery when depressed and stop and effectively brake the machinery when released.

8.3.9 The above mentioned individual push-buttons may be replaced by two ‘start’ and ‘stop’ push-buttons.

8.4 Maintenance arrangements

8.4.1 Access is to be provided for inspection of reduction gears, bearings, brakes, etc.

8.4.2 Accessible manual lubrication points, including nipples, are to be provided for both for oil and grease, as applicable.

8.4.3 Gear-boxes are to be provided with adequate access arrangements for monitoring and replacing oil.

8.5 Protection arrangements

8.5.1 Where applicable, moving parts of windlass machinery are to be provided with suitable railings and/or guards to prevent injury to personnel.

8.5.2 Protection is to be provided for preventing persons from coming into contact with surfaces having temperatures over 50°C.

8.5.3 Steel surfaces not protected by lubricant are to be protected by a coating, in accordance with the requirements of a relevant National or International Standard acceptable to LR.

8.6 Marking and identification

8.6.1 Controls are to be permanently marked for identification, unless their functions are readily apparent. If required, instructions are to be permanently marked and readily visible.

Existing sub-Sections 8.3 *and* 8.4 *are to be renumbered* 8.7 *and* 8.8.

Volume 2, Part 1, Chapter 2
Requirements for Design, Construction, Installation and Sea Trials of Engineering Systems

Effective date 1 January 2011

■ *Section 3*
Particulars to be submitted

3.2 Plans

3.2.2 Individual Chapters list plans to be submitted for specific machinery and electrical systems or components. Also required are the following arrangement plans and information, where applicable:

(a) Plans showing the arrangement of machinery spaces indicating the location of machinery and equipment together with means of access and ventilation;

(b) Plans showing the maintenance envelope and removal routes of machinery and equipment where routine removal for maintenance is proposed;

(c) Where requested in individual chapters, design statements which detail the system's capability and functionality under defined operating and emergency conditions. These design statements are to be agreed between the designer and owner/operator.

■ *Section 4*
Operating Conditions

~~4.16 Failure of control operating medium~~

~~*4.16.1* Diesel engines and gas turbines are to be capable of operation at the maximum continuous power after loss or reduction of the normal control system operating medium, e.g. hydraulic, pneumatic or electrical, in accordance with the requirements in 4.16.2 to 4.16.4.~~

~~*4.16.2* All electrical controls and alarms, necessary for operation of diesel engines and gas turbines, are to remain operational using an emergency backup supply system (that may be battery powered) for a period of at least one hour after total failure of the main electrical supply. Diesel engines and gas turbines are to be capable of being started and operated throughout the range of ambient conditions in 4.4 without the use of power from the ship's electrical supply system.~~

~~*4.16.3* Any hydraulic, pneumatic or electrical control and alarm systems are to be arranged so that any diesel engine or gas turbine operating at the time of failure will continue to operate safely for a period of at least one hour under the control mode selected at the time of failure, i.e. successful control system changeover is not to be a precondition for continued safe operation. Engine monitoring and alarm systems required by the Rules are to be available at all times.~~

~~*4.16.4* Emergency hand control is to be provided where necessary to enable the requirements for safe operation called for by 4.16.2 to be assured following auto and/or remote control system failure.~~

Existing sub-Sections 4.17 *to* 4.20 *are to be renumbered* 4.16 *to* 4.19*.*

■ *Section 5*
Machinery space arrangements

5.11 Personnel safety

5.11.6 Materials used in the construction of machinery and installation of engineering systems are not to be a recognised hazard to personnel. This includes the prohibition of asbestos, ~~except in the following applications where agreed by LR and the Naval Authority:~~

~~*(a).* Vanes used in rotary vane compressors and rotary vane pumps;~~

~~*(b).* Watertight joints and linings used for the circulation of fluids when at high temperature (in excess of 350°C) or pressure (in excess of 70 bar (7 MP_a)) there is a risk of fire, corrosion or toxicity;~~

~~*(c).* Supple and flexible thermal insulation assemblies used for temperatures above 1000°C.~~

■ *Section 6*
Diesel engines

6.3 Hydraulic testing

Table 2.6.1 Test pressures

Item	Test pressure
Fuel injection equipment including: Pump body, pressure side Valve Pipe	The lesser of 1,5*p* or *p* + ~~295~~ 300 bar
Cylinder cover cooling space Cylinder liner, over the whole length of cooling space Piston crown, cooling space (where piston rod seals cooling space, test after assembly)	7,0 bar
Cylinder jacket, cooling space Exhaust valve, cooling space Turbo-charger, cooling space Exhaust pipe, cooling space Coolers, each side Engine driven pumps (oil, water, fuel, bilge)	The greater of 4,0 bar or 1,5*p*
Air compressor, including cylinders, covers, intercoolers and aftercoolers	Air side: 1,5*p* Water side: the greater of 4,0 bar or 1,5*p*
Scavenge pump cylinder	4,0 bar
Hydraulic systems (piping, pumps, actuators)	1,*5p*

NOTES
1. *p* is the maximum working pressure, in bar, in the item concerned.
2. Pumps used in jerk or timed pump systems need only have the assembled high pressure containing components hydraulically tested.
3. Turbo-charger air coolers need only be tested on the water side.
4. For forged steel cylinder covers and piston crowns alternative testing methods ~~will~~ may be specially considered.
5. For hydraulic systems where design features are such that modifications to the test requirements are necessary, alternative proposals for hydraulic tests are to be submitted for special consideration.

■ *Section 16*
Sea Trials

16.3 Performance testing

16.3.6 The following information is to be available on board for the use of designated personnel:

- The results of trials to determine stopping times, ship headings and distance;
- For ships having multiple propellers, the results of trials to determine the ability to navigate and manoeuvre with one or more propellers inoperative~~.~~;
- For ships having a single propulsor driven by multiple engines or electric motors, the results of trials to determine the ability to navigate and manoeuvre with the largest engine or electric motor inoperative.

Volume 2, Part 2, Chapter 1
Diesel Engines

Effective date 1 January 2011

■ *Section 2*
Particulars to be submitted

2.1 Plans and information

2.1.2 The following information and calculations are to be submitted:

- Crankshaft design data as outlined in Section 4.
- Combustion pressure-displacement relationship.
- Power/speed operational envelope.
- Calculations and information for short term high power operation where applicable.
- Arrangement and welding specifications with details of the procedures for fabricated bedplate, thrust bearing bedplate, crankcases, frames and entablatures. Details of materials, welding consumables, fit-up conditions, fabrication sequence and heat treatments are to be included.
- Operation and maintenance manuals.
- Material specifications covering the listed components together with details of any surface treatments, non-destructive testing and hydraulic tests.
- Arrangement of interior lighting, where provided.
- Engine Type test programme where required, including proposals for short term high power operation.
- Alternative proposals for hydraulic tests where design features are such that modifications to the test requirements are necessary.
- Thrust bearing assembly (if integral with engine and not integrated in the bedplate).
- Counterweights, where attached to crank-throw, including fastening.
- Main engine holding down arrangement.
- Design statement for engine systems, *see* Pt 1, Ch 2,3.2.2(c) and 15.2.

■ *Section 6*
Safety arrangements on engines

6.7 Oil mist detection/monitoring

6.7.2 The oil mist detection~~/monitoring~~ system and arrangements are to be installed in accordance with the engine designer's and oil mist detection equipment manufacturer's instructions/recommendations. The following particulars are to be included in the instructions:

(a) Schematic layout of engine oil mist detection~~/monitoring~~ and alarm system showing locations of engine crankcase sample points and cabling/piping arrangements together with pipe dimensions to detector~~/monitor~~.

(b) Evidence of study to justify the selected locations of sample points and sample extraction rate (if applicable) in consideration of the crankcase arrangements and geometry and the predicted crankcase atmosphere where oil mist can accumulate.

(c) The manufacturer's maintenance and test manual.

(d) Information relating to type or in-service testing of the engine with engine protection system test arrangements having approved types of oil mist ~~monitoring~~ detection equipment.

6.7.3 A copy of the oil mist detection~~/monitoring~~ equipment maintenance and test manual required by 6.7.2 is to be provided on board ship.

6.7.4 Oil mist ~~monitoring~~ detection and alarm information is to be capable of being read from a safe location away from the engine.

6.7.5 In the case of multi engine installations, each engine is to be provided with individual, dedicated oil mist detection~~/monitoring~~ arrangements and ~~a dedicated~~ alarm(s).

6.7.6 Oil mist detection~~/monitoring~~ and alarm systems are to be capable of being tested on the test bed and on board when the engine is at a standstill and when the engine is running at normal operating conditions in accordance with test procedures that are acceptable to LR.

6.7.7 Alarms and ~~shutdowns~~ safeguards for the oil mist detection~~/monitoring~~ system are to be in accordance with Pt 6, Ch 1 as applicable.

6.7.8 The oil mist detection~~/monitoring~~ arrangements are to provide an alarm indication in the event of a foreseeable functional failure in the equipment and installation arrangements. *See* Pt 6, Ch 1,2.4.6.

6.7.9 The oil mist detection~~/monitoring~~ system is to provide an indication that any lenses fitted in the equipment and used in determination of the oil mist level have been partially obscured to a degree that will affect the reliability of the information and alarm indication.

6.7.10 Where oil mist detection~~/monitoring~~ equipment includes the use of programmable electronic systems, the arrangements are to be in accordance with Pt 6, Ch 1 as applicable.

6.7.11 Schematic layouts showing details and arrangements of oil mist detection~~/monitoring~~ and alarm systems are to be submitted. *See* Pt 5, Ch 1,1.

6.7.12 The equipment together with detectors~~/monitors~~ is to be tested when installed on the test bed and on board ship to demonstrate that the detection~~/monitoring~~ and alarm system functions correctly. The testing arrangements are to be to the satisfaction of the Surveyor.

6.7.13 Where sequential oil mist detection~~/monitoring~~ arrangements are provided, the sampling frequency and time is to be as short as reasonably practicable.

6.7.14 Where engine bearing temperature monitors or alternative methods are provided for the prevention of the build up of oil mist that may lead to a potentially explosive condition within the crankcase, detailed information is to be submitted for consideration. The information is to include:

(a) Engine particulars – type, power, speed, stroke, bore and crankcase volume.
(b) Details of arrangements designed to prevent the build up of potentially explosive conditions within the crankcase, e.g., bearing temperature monitoring, oil splash temperature monitoring, crankcase pressure monitoring, and recirculation arrangements.
(c) Evidence to demonstrate that the arrangements are effective in preventing the build up of potentially explosive conditions together with details of in-service experience.
(d) Operating instructions and the maintenance and test instructions.

6.7.15 Where it is proposed to use the introduction of inert gas into the crankcase to minimise a potential crankcase explosion, details of the arrangements are to be submitted for consideration.

■ *Section 9*
Control and monitoring

9.1 General

(*Part only shown*)

9.1.2 ~~While it is recommended that oil mist monitoring or engine bearing temperature monitors for crankcase protection be fitted, they are in any case to be provided~~ Oil mist detection, engine bearing temperature monitors or alternative methods for crankcase protection are to be provided:

NOTES

5. Where engine bearing temperature monitors or alternative methods are provided for the prevention of the build up of oil mist that may lead to a potentially explosive condition within the crankcase, details are to be submitted for consideration. The submission is to demonstrate that the arrangements are equivalent to those provided by oil mist detection, *see* 6.7.14.

9.6 Unattended machinery

Table 1.9.1(a) Diesel engines for propulsion purposes: Alarms and slow-downs (*See continuation*)

Item	Alarm	Note
Lubricating oil sump level	Low	Engines (and gearing if fitted)
Lubricating oil inlet pressure*	1st stage Low	Engines (and gearing if fitted). Slow-down
Lubricating oil inlet temperature*	High	Engines (and gearing if fitted)
Lubricating oil filters differential pressure	High	—
Oil mist concentration in crankcase or bearing temperature	High	Automatic slow-down of slow speed engines, *see* 9.1.2
Cylinder lubricator flow	Low	One sensor per lubricator unit. Slow-down (automatic on medium and high speed engines)
Thrust bearing temperature*	High	Slow-down
Common rail servo oil pressure		Low
Piston coolant inlet pressure	Low	If a separate system. Slow-down
Piston coolant outlet temperature*	High	Per cylinder (if a separate system). Slow-down
Piston coolant outlet flow*	Low	Per cylinder (if a separate system). Slow-down
Cylinder coolant inlet pressure or flow*	Low	Slow-down (automatic on medium and high speed engines)
Cylinder coolant outlet temperature*	1st stage high	Per cylinder (if a separate system). Slow-down (automatic on medium and high speed engines)
Engine cooling water system – oil content	High	Where engine cooling water used in heat exchangers
Sea water cooling pressure	Low	—
Fuel valve coolant pressure	Low	If a separate system
Fuel valve coolant temperature	High	If a separate system
Oil fuel pressure from booster pump	Low	—
Oil fuel temperature or viscosity*	High and Low	Heavy oil only
Common rail fuel oil pressure	Low	
Oil fuel high pressure piping*	Leakage	*See* 9.6.3
Charge air cooler outlet temperature	High and Low	4-stroke medium and high speed engines
Scavenge air temperature (fire)	High	Per cylinder, (2 stroke engines). Slow-down

Table 1.9.1(a) Diesel engines for propulsion purposes: Alarms and slowdowns (*conclusion*)

Item	Alarm	Note
Scavenge air receiver water level	High	—
Exhaust gas temperature*	High	Per cylinder. Slow-down (automatic on medium and high speed engines)
Exhaust gas temperature deviation from average*	High	Per cylinder, for engine power >500 kW/cylinder. *See* Note 5
Turbocharger exhaust gas inlet temperature	High	Each turbocharger
Turbocharger exhaust gas outlet temperature*	High	Each turbocharger
Turbocharger lubricating oil inlet pressure	Low	If system not integral with turbocharger
Turbocharger lubricating oil outlet temperature	High	Each bearing, if system not integral with turbocharger. *See* Note 6
Starting air pressure*	Low	Before engine manoeuvring valve
Control air pressure	Low	—
Direction of rotation	Wrong way	Reversible engines, *see also* 9.7.7
~~Overspeed*~~	~~High~~	~~*See also* 9.4~~
Automatic start of engine	Failure	*See* 9.7.7
Electrical starting battery charge level	Low	—
Feed water or water/thermal fluid forced circulation flow (if fitted)	Low	*See* Pt 7, Ch 3,6.2.6 and Note 6
Uptake temperature	High	To monitor for soot fires. *See* Notes 6 and 7

NOTES
1. Where 'per cylinder' appears in this Table, suitable alarms may be situated on manifold outlets for medium and high speed engines.
2. For engines and gearing of 1500 kW or less only the items marked * are required.
3. Common sensors are acceptable for alarms and slow-down functions.
4. Except where stated otherwise in the Table, slow-down may be effected by either manual or automatic means, by reduction of speed or power as appropriate.
5. For engine powers <500 kW/cylinder, but total power >500 kW, a common sensor for exhaust gas manifold temperature is to be fitted.
6. Alarm only required when an exhaust gas economiser/boiler/thermal oil heater is fitted.
7. Alternatively, details (including location) of an appropriate fire detection system are to be submitted for consideration.
8. Where the outlet temperature for each bearing cannot be measured due to the design, details of alternative proposals in accordance with the turbocharger manufacturer's instructions may be submitted for consideration.

Table 1.9.1(b) Diesel engines for propulsion purposes: Alarms and shut-downs

Item	Alarm	Note
Lubricant oil inlet pressure	2nd stage low	Automatic shut-down of engines (and gearing if fitted), *see* 9.6.2
Oil mist concentration in crankcase or bearing temperature	High	Automatic shut-down of medium and high speed engines, *see* 9.1.2
Cylinder coolant outlet temperature	2nd stage high	Automatic shut-down of medium and high speed engines, *see* 9.6.2
Overspeed	High	Automatic shut-down of engine, *see also* 9.4. Details of alternative proposals in accordance with the manufacturer's instructions may be submitted for consideration.

Table 1.9.2 Auxiliary diesel engines: Alarms and shut-downs

Item	Alarm	Note
Lubricating oil inlet temperature	High	—
Lubricating oil inlet pressure	1st stage low	—
	2nd stage low	Automatic shut-down of engine, *see* 9.6.2
Oil mist concentration in crankcase or bearing temperature	High	Automatic shut-down of engine, *see* 9.1.2
Oil fuel high pressure piping	Leakage	*See* 9.6.3
Coolant outlet temperature (for engines >220 kW)	1st stage high	—
	2nd stage high	Automatic shut-down of engine, *see* 9.6.3
Coolant pressure or flow	Low	—
Oil fuel temperature or viscosity	High and Low	Heavy oil only
Overspeed	High	~~*See 9.4*~~ Automatic shut-down of engine, *see also* 9.4. Details of alternative proposals in accordance with the manufacturer's instructions may be submitted for consideration.
Common rail servo oil pressure	Low	
Common rail fuel oil pressure	Low	
Starting air pressure	Low	—
Electrical starting battery charge level	Low	—
Exhaust gas temperature (for engines >500 kW/cylinder)	High	Per cylinder. ~~For engine power <500 kW/cylinder, common sensors for each inlet to the turbocharger may be accepted.~~
Feed water or water/thermal fluid forced circulation flow (if fitted)	Low	*See* Pt 7, Ch 3,6.2.6
Uptake temperature	High	To monitor for soot fires. *See* Notes 2 and 3

NOTES

1. The arrangements are to comply with the requirements of the Naval Authority concerned.
2. Alarm only required when an exhaust gas economiser/boiler/thermal oil heater is fitted.
3. Alternatively, details (including location) of an appropriate fire detection system are to be submitted for consideration.

■ *Section 15* Electronically controlled engines

15.4 Electronic control systems

15.4.2 Programmable electronic equipment self-monitoring capabilities, *see* Pt 9, Ch 1,2.10.7, are to include, at least:

- ~~watchdog~~ facilities to monitor for system lock-ups (program hangs);
- means to detect whether starting, shut-down and control command data communication links are operational; and
- power supply failure including as a result of internal fuse or protective device operation.

Volume 2, Part 2, Chapter 2
Gas Turbines

Effective date 1 January 2011

■ *Section 7*
Control, alarm and safety systems

7.9 Automatic and remote controls

(*Part only shown*)

Table 2.7.1 Gas turbine machinery: Alarms and shut-downs

Item	Alarm	Note
Automatic starting	Failure	Automatic shut-down
Control system	Failure	Automatic shut-down
Air intake pressure	Low	*See also* 4.4
Feed water or water/thermal fluid forced circulation flow (if fitted)	Low	*See* Pt 7, Ch 3,6.2.6 and Note 5
Uptake temperature	High	To monitor for soot fires. *See* Notes 5 and 6

NOTES
1. For two-stage alarms, *see also* 7.9.3.
2. For requirements on purging before ignition, *see* 6.2.1.
3. Where there are separate lubricating oil systems for gas generator and power turbine/gearing sections, each system is to be monitored.
4. Where there is more than one combustion chamber, the temperature of each chamber is to be monitored.
5. Alarm only required when suitable for operation on residual fuel grades and an exhaust gas economiser/boiler/thermal oil heater is fitted.
6. Alternatively, details (including location) of an appropriate fire detection system are to be submitted for consideration.

Volume 2, Part 3, Chapter 1
Gearing

Effective date 1 January 2011

■ *Section 5*
Plans and particulars to be submitted

5.3 Design data and calculations

5.3.1 A design statement for the gearing installation ~~that details system capability and functionality under defined operating and emergency conditions~~, *see* Pt 1, Ch 2, 3.2.2(c).

Volume 2, Part 3, Chapter 2
Shafting Systems

Effective date 1 January 2011

■ *Section 4*
Design and construction

4.4 Screwshafts and tube shafts

4.4.8 The diameter of ~~the~~ unprotected ~~screwshaft~~ screwshafts of materials having properties as shown in Table 2.4.1 forward of the forward stern tube seal ~~need not be greater than the diameter as required by 4.4.6~~ is to be determined in accordance with 4.4.3 or 4.4.7, whichever is less.

Volume 2, Part 4, Chapter 4
Shafting Systems

Effective date 1 January 2011

■ *Section 2*
General requirements

2.2 Plans and information to be submitted

(*Part only shown*)
2.2.1. In addition to the plans required by Pt 3, Ch 1 and Ch 2, Pt 4, Ch 1, Pt 5, Pt 6, Ch 1, Pt 7, Ch 3 and Parts 9 and 10, the following plans and information are required to be submitted for appraisal:

(z) Quality plan for electronic control systems and electrical actuating systems.

■ *Section 8*
Control engineering ~~arrangements~~ systems

8.1 General

8.1.8 For electronic control systems and electrical actuating systems, ~~the~~ an overall quality plan for sourcing, design, installation and testing ~~of components~~ is to address the following issues:

(a) Standard(s) applied;
(b) Details of the quality control system applied during manufacture and testing;
(c) Details of type approval, type testing or approved type status assigned to the equipment;
(d) Details of installation and testing recommendations for the equipment;
(e) Details of any local and/or remote diagnostic arrangements where assessment and alteration of control parameters can be made which can affect the operation of the podded propulsor unit;
(f) ~~Details of~~ Software lifecycle activities, including configuration management and arrangements for software upgrades.

8.1.9 The ~~system integration is required~~ quality plan referred to in 8.1.8 is to identify the process for verification of the functional outputs from the electronic control systems with particular reference to system integrity, consistency, security against unauthorised changes to software and maintaining the outputs within acceptable tolerances of stated performance for safe and reliable operation of the podded propulsor unit.

8.2 Monitoring and alarms

8.2.8 Means are to be provided to identify the cause of propulsion motor power limitation or automatic reduction.

Table 4.8.1 Specific alarms for pod control systems

Item	Alarm	Note
Podded drive azimuth angle	—	Indicator, *see* 8.1.4
Propulsion motors	Overload, power failure	To be indicated on the navigating bridge
Propulsion motor power limitation or automatic reduction	Activated	*See also* 8.2.8
Hydraulic oil system pressure	Low	To be indicated on the navigating bridge
Bearing temperature	High	For grease lubricated bearings
Motor temperature	High	*See* Pt 10, Ch 1,5.1.3
Lubricating oil supply pressure	Low	If separate forced lubrication for shaft bearings; to be indicated on the navigating bridge
Lubricating oil temperature	High	
Lubricating oil tank level for motor bearings	Low	
Water in lubricating oil for motor bearings	High	Required for single podded propulsion units only
Motor cooling air inlet temperature	High	
Motor cooling air outlet temperature	High	
Motor cooling air flow	Low	
Shaft bearing vibration monitoring	High	*See* 6.3.10. Monitoring is to allow bearing condition to be gauged using trend analysis
Dry space water pump operation	Abnormal	Alarm set to indicate a frequency or duration exceeding that which would normally be expected
Dry space water level	High	

Volume 2, Part 5, Chapter 1
Torsional Vibration

Effective date 1 January 2011

■ *Section 2*
Details to be submitted

2.2 Scope of calculations

2.2.3 The calculations carried out on oil engine systems are to be based on the Enginebuilders' harmonic torque data ~~(on request, Lloyd's Register (hereinafter referred to as 'LR') can provide a table of generalised harmonic torque components for use where appropriate)~~. The calculations are to take account of the effects of engine malfunctions commonly experienced in service, such as a cylinder not firing (i.e. no injection but with compression) giving rise to the highest torsional vibration stresses in the shafting. Calculations are also to take account of a degree of imbalance between cylinders, which is characteristic of the normal operation of an engine under service conditions.

Volume 2, Part 7, Chapter 1
Piping Design Requirements

Effective date 1 January 2011

■ *Section 2*
General

2.1 Documentation

2.1.1 Documents indicating the following information are to be submitted for each piping system in triplicate:

Design pressure.
Design temperature.
Class of system.
Internal pipe diameter and thickness.
Material specification.
Corrosion protection.
Corrosion allowance.
Pipe connection specifications.
Valve specifications.
Flexible hose specifications.
Expansion piece specifications.
Details of any other pipe fittings.
Pumping unit type and discharge characteristics.
Testing procedures.
Design statements for heat exchangers as required by 18.1.11.

■ *Section 4*
Materials

4.1 Metallic materials

4.1.4 The Manufacturer's materials ~~test~~ certificate validated by LR will be accepted for all classes of piping and components in lieu of an LR materials certificate where the maximum design conditions are less than shown in Table 1.4.1. *See* Ch 1,3.1.3(b) of the Rules for Materials.

4.1.5 The Manufacturer's ~~test~~ certificate validated by LR for materials for ship-side valves and fittings and valves on the collision bulkhead equal to or less than 500 mm nominal diameter will be accepted in lieu of LR's materials certificate where the valves and fittings are in accordance with a recognised National Standard applicable to the intended application and are manufactured and tested in accordance with the appropriate requirements of the Rules for Materials. *See* Ch 1,3.1.3(b) of the Rules for Materials.

■ *Section 6*
Carbon and low alloy steel piping and components

6.1 Wrought steel pipes and bends

6.1.1 The maximum permissible design stress, σ, is to be taken as the lowest of the following values:

$$\sigma = \frac{E_t}{1,6} \qquad \sigma = \frac{R_{20}}{2,7} \qquad \sigma = \frac{S_R}{1,6}$$

where

E_t = specified minimum lower yield or 0,2 per cent proof stress at the design temperature. In the case of stainless steel, the 1,0 per cent proof stress at design temperature is to be used

R_{20} = specified minimum tensile strength at ambient temperature

S_R = average stress to produce rupture in 100 000 hours at the design temperature

6.1.5 Where the minimum thickness calculated by 6.1.3 or 6.1.4 is less than that shown in Table 1.6.4, the minimum nominal thickness for the appropriate standard pipe size shown in the Table is to be used. No allowance is required for negative tolerance, corrosion or reduction in thickness due to bending on this nominal thickness. For larger diameters, the minimum thickness will be ~~specially~~ considered. For threaded pipes, where permitted, the minimum thickness is to be measured at the bottom of the thread.

■ *Section 7*
Copper and copper alloy piping and components

7.1 Copper and copper alloy pipes, valves and fittings

7.1.2 Materials for Class III piping systems are to be manufactured and tested in accordance with the requirements of acceptable national specifications. The manufacturer's test certificate will be acceptable and is to be provided for each consignment of material. *See* Ch 1,3.1.3(c) of the Rules for Materials.

■ *Section 8*
Cast Iron piping and componentss

8.1 Spheroidal or nodular graphite cast iron

8.1.3 Castings for Class II systems, also for ship-side valves and fittings and valves on the collision bulkhead, are to be manufactured and tested in accordance with the requirements of Chapter 7 of the Rules for Materials. Castings for Class III systems are to comply with the requirements of acceptable National specifications. A manufacturer's test certificate will be accepted and is to be provided for each consignment of material for Class III systems, *see also* ~~4.1~~ 1.6 and Ch 1,3.1.3(c) of the Rules for Materials.

■ *Section 9*
Stainless steel piping and components

9.1 General

9.1.2 The minimum thickness of stainless steel pipes is to be determined from the formula given in 6.1.3 or 6.1.4 using a corrosion allowance of 0,8 mm. Values of the ~~0,2~~ 1,0 per cent proof stress and tensile strength of the material for use in the formula in 6.1.1 may be obtained from Table 6.5.2 of the Rules for Materials.

9.1.3 Where stainless steel is used in lubricating oil and hydraulic oil systems, the corrosion allowance may be reduced to ~~0,3~~ 0 mm. For pipes passing through tanks, an additional corrosion allowance is to be added to take account of external corrosion; the addition will depend on the external medium and the value is to be in accordance with Table 1.6.3.

~~**Table 1.9.1 Minimum thickness for stainless steel pipes**~~

Standard pipe sizes (outside diameter)			Minimum nominal thickness
mm		mm	mm
8,0	to	10,0	0,8
12,0	to	20,0	1,0
25,0	to	44,5	1,2
50,0	to	76,1	1,5
88,9	to	108,0	2,0
133,0	to	159,0	2,5
193,7	to	267,0	3,0
273,0	to	457,2	3,5

Table 1.9.1 Minimum thickness for stainless steel pipes

Standard pipe sizes, (outside diameter), in mm			Min.nominal thickness, in mm
8,0	to	10,0	0,8
10,2	to	17,2	1,0
21,3	to	48,3	1,6
60,3	to	88,9	2,0
114,3	to	168,3	2,3
219,1			2,6
273,0			2,9
323,9 over	to 406,4	406,4	3,6 4,0

■ *Section 11*
Plastic piping and components

11.2 Design and performance criteria

11.2.4 Plastics piping ~~is~~, connections and fittings are to be electrically conductive when:

(a) carrying fluids capable of generating electrostatic charges.

(b) passing through ~~dangerous~~ hazardous zones and spaces, regardless of the fluid being conveyed.

Suitable precautions against the build up of electrostatic charges are to be provided in accordance with the requirements of 11.5, *see also* Pt 10, Ch 1,1.12.

11.6 Manufacture and quality control

11.6.1 All materials for plastics pipes and fittings are to be approved by LR, and are in general to be tested in accordance with Ch 14,4 of the Rules for Materials. For pipes and fittings not employing hand lay up techniques, the hydrostatic pressure test required by Ch 14,4.9 of the Rules for Materials may be replaced by testing carried out in accordance with the requirements stipulated in a National or International Standard, consistent with the intended use for which the pipe or fittings are manufactured, provided there is an effective quality system in place complying with the requirements of Ch 14,4.4 of the Rules for Materials and the testing is completed to the satisfaction of the LR Surveyor.

■ *Section 18*
Heat exchangers

18.1 General

18.1.6 Heat exchangers are to be capable of stable operation at their specified rating under all envisaged operating conditions, *see* Pt 1, Ch 2,4. Any degraded performance under declared extreme environmental operating conditions is to be stated by the manufacturer and included in the design statement required by ~~18.1.10~~ 18.1.11.

Volume 2, Part 7, Chapter 2
Ship Piping Systems

Effective date 1 January 2011

■ *Section 3*
Drainage of compartments, other than machinery spaces

3.1 General

3.1.6 For a normally inaccessible small void compartment such as an echo sounding compartment, which is accessed from within a normally inaccessible space such as a forepeak tank, alternative drainage arrangements to those required by 3.1.1 may be considered. For such arrangements, a warning notice is to be located in a prominent position specifying the precautions to be taken prior to opening the manhole of the small void compartment. Means are to be provided to indicate flooding of the compartment without opening, such as fitting indicator plugs to the manhole. Drainage arrangements are to be submitted to LR for approval.

■ *Section 7*
Piping systems and their fittings

7.4 Compartment suctions – Strum boxes

7.4.1 The open ends of bilge and dewatering suctions in compartments outside machinery spaces and tunnels, such as cofferdams and tanks other than those permanently arranged for the carriage of fresh water, water ballast or oil fuel and for which other efficient means of pumping are provided, are to be enclosed in strum boxes having perforations of not more than 10 mm diameter, whose combined area is not less than twice that required for the suction pipe. The boxes are to be so constructed that they can be cleared without breaking any joint of the suction pipe.

■ *Section 10*
Air, overflow and sounding pipes

10.3 Air pipes

10.3.4 For a normally inaccessible small void compartment such as an echo sounding compartment, which is accessed from within a normally inaccessible space such as a forepeak tank, alternative air pipe arrangements to those required by 10.3.1 may be considered. For such arrangements, a warning notice is to be located in a prominent position specifying the precautions to be taken prior to opening the manhole and entering the small void compartment. Ventilation arrangements are to be submitted to LR for approval.

10.10 Sounding arrangements

10.10.7 For a normally inaccessible small void compartment such as an echo sounding compartment, which is accessed from within a normally inaccessible space such as a forepeak tank, alternative sounding arrangements to those required by 10.10.1 may be considered. For such arrangements, a warning notice is to be located in a prominent position specifying precautions to be taken prior to opening the manhole of the small void compartment. Means are to be provided to indicate flooding of the compartment without opening, such as fitting indicator plugs to the manhole. Sounding arrangements are to be submitted to LR for approval.

Volume 2, Part 7, Chapter 3
Machinery Piping Systems

Effective date 1 January 2011

■ *Section 5*
Steam Piping Systems

5.3 Soot cleaning drains

5 3.1 The capacity of the drains from exhaust gas economisers/boilers is to be sufficient to remove all wash water or condensate generated by installed washing systems, and arrangements are to be such that engines and turbochargers are protected from wash water or condensate drainage from the washing system.

5.3.2 Adequate arrangements are to be made for the collection and disposal of the waste water generated during periodic water washing of the exhaust gas economiser/boiler. Details are to be submitted for approval.

Existing sub-Section 5.3 *is to be renumbered to* 5.4.

■ *Section 6*
Boiler feed water ~~and~~, condensate and thermal fluid circulation systems

6.2 Feed and circulation pumps

6.2.4 The arrangement of forced water/thermal fluid circulation pumps for exhaust gas economisers/boilers/ thermal heaters is to be such that where required, the flow through the exhaust gas economiser/boiler/thermal heater is to be established prior to engine start up. Where applicable, provision is to be made to allow for operation in the dry condition.

6.2.5 The forced circulation flow required by 6.2.4 is to be maintained on completion of engine shutdown for a sufficient duration in accordance with the exhaust gas economiser/boiler/thermal heater manufacturer's instructions. Details of arrangements are to be submitted for approval.

6.2.6 Where arrangements are such that exhaust gas economisers/boilers/thermal heaters require forced water /thermal fluid circulation, standby pumps are to be fitted. The standby pump is to start automatically if the discharge pressure from the working pumps falls below a predetermined value.

■ *Section 9*
Control, supervision and monitoring of equipment

9.3 Thermal fluid heaters

Table 3.9.1 Thermal fluid heaters: Alarms and safeguards (*see continuation*)

Item	Alarm	Note
Expansion tank level*	Low	Oil fuel burners to be shut off automatically
Thermal fluid flow	Low	Oil fuel burners to be shut off automatically, *see* Note 5
Thermal fluid pressure	Low	Oil fuel burners to be shut off automatically
Thermal fluid outlet temperature*	1st stage High	—
	2nd stage High	Oil fuel burners to be shut off automatically, *see* 9.2.3
Thermal fluid forced circulation flow (if fitted)	Low	For exhaust gas economisers/boilers, *see* Note 5
Combustion air pressure*	Low	Oil fuel burners to be shut off automatically, *see* Note 3
Oil fuel pressure*	Low	—
Oil fuel temperature or viscosity*	High and low	Heavy oil only
Oil fuel atomising steam/air pressure	Low	—
Burner flame*	Failure	Each burner to be monitored. Oil fuel to burners to be shut off automatically, *see* 3.1.9 to 3.1.10 and Note 3
Flame monitoring device(s)*	Failure	*See* 9.3.6 and Note 3
Igniter*	Failure	Each igniter to be checked before oil is supplied to burner, *see* 9.3.5 and Note 3
Forced draft fan*	Power failure	Oil fuel to burners to be shut off automatically, *see* Note 3
Air register and dampers (including those in the uptake)*	Not fully open	Purge sequence to be inhibited, *see* 3.1.7
Control system*	Power failure	Oil fuel to burners to be shut off automatically. Control using alternative arrangements is to remain available, *see* Pt 9, Ch 1,2.5.7.
Uptake temperature	High	~~Where applicable, to~~ To monitor for soot fires. Oil fuel to the burner is to be shut off, *see* Notes 4 and 6

Volume 2, Part 7, Chapters 3, 4 and 5

Table 3.9.1 Thermal fluid heaters: Alarms and safeguards (*conclusion*)

NOTES
1. Special consideration may be given to the requirements for oil fired hot water heaters.
2. For heaters not supplying thermal fluid for services essential for the safety or the operation of the ship at sea, only the items marked* are required.
3. These safeguards are to remain operative during automatic, manual and emergency operation.
4. Alarm and oil fuel shut-off only required where exhaust gas economisers/boilers are fitted.
5. For exhaust gas economisers/boilers requiring thermal fluid forced circulation, the low flow alarm is to be fitted with provision to override the alarm if the exhaust gas economiser/boiler is to be operated in the dry condition. *See also* Ch 3,6.2.4.
6. Alternatively, details (including location) of an appropriate fire detection system are to be submitted for consideration.

Volume 2, Part 7, Chapter 4
Aircraft/Helicopter/Vehicle Fuel Piping and Arrangements

Effective date 1 January 2011

■ *Section 1*
General Requirements

1.2 Plans and particulars

1.2.2 **Design statement.** A design statement ~~that details the system capability and functionality under defined operating and emergency conditions~~ is to be submitted for information, *see* Pt 1, Ch 2, 3.2.2(c).

Volume 2, Part 7, Chapter 5
Ship Type Piping Systems

Effective date 1 January 2011

■ *Section 1*
General Requirements

1.3 Plans and information

1.3.2 **Design statement.** A design statement of each Ship Type piping system~~ that details system capability and functionality under defined operating and emergency conditions. The design statement is to be agreed between the Designers and Owners/Operators~~, *see* Pt 1, Ch 2, 3.2.2(c).

Volume 2, Part 8, Chapter 1
Steam Raising Plant and Associated Pressure Vessels

Effective date 1 January 2011

■ *Section 1*
General requirements

1.13 Exhaust gas economiser/boiler arrangements

1.13.1 The design of exhaust gas economisers/boilers of the plain or extended surface fin tube types is to be compatible with the installed engine design parameters. The parameters which influence the build up of soot deposits and overheating such as fuel, exhaust gas temperature and efflux velocity are to be considered in the design of the exhaust gas economiser/boiler for use with the installed engine, in order to minimise the risk of fire and breakdown during operation.

1.13.2 A design statement demonstrating compliance with the requirements of 1.13.1 or alternative means of preventing the accumulation of soot or overheating, such as the use of exhaust gas bypass ducting with automatic flap valve arrangements and/or effective soot prevention and cleaning systems, is to be submitted for approval.

■ *Section 15*
Mountings and fittings for cylindrical and vertical boilers, steam generators, pressurised thermal liquid and pressurised hot water heaters

15.2 Safety valves

15.2.8 Each safety valve chest is to be drained by a pipe fitted to the lowest part and led with a continuous fall to the bilge or to a tank, clear of the boilers. No valves or cocks are to be fitted to these drain pipes. ~~It is recommended that the~~ The bore of the drain pipes is to be not less than 19 mm.

15.2.10 To avoid the accumulation of solid matter deposits on the outlet side of the safety valves and bursting discs required by 15.2.9, the discharge pipes and safety valve/bursting disc housings are to be fitted with drainage arrangements from the lowest part, directed with continuous fall to a position clear of the economiser where it will not pose a threat to either personnel or machinery. No valves or cocks are to be fitted in the drainage arrangements. The drainage arrangements required by 15.2.8 may be accepted as meeting these requirements where the arrangements comply with this paragraph.

15.2.15 Pressurised thermal liquid and pressurised hot water heaters are to be provided with a safety relief device. The safety valve is to be designed and constructed in accordance with a relevant National or International Standard acceptable to LR.

■ *Section 18*
Control and monitoring

18.2 Automatic and remote controls

(*Part only shown*)

Table 1.18.1 Boilers: Alarms and safeguards (*see continuation*)

Item	Alarm	Note
Feed water or water forced circulation flow (if fitted)	Low	Oil fuel to burners to be shut off automatically, *see* Notes 5 and 6
Uptake temperature	High	Where economiser and/or gas air heaters are integral with the boiler and also for independent ~~extended surface~~ exhaust gas boilers/economisers, to monitor for soot fires. *See* Note 7

NOTES
1. For dual evaporation boilers the primary circuit is to be fitted with two independent low water level detectors which will operate alarms and shut off the oil fuel to the burners automatically. The secondary circuit is to be fitted with one low water level detector which will operate alarms and shut off the oil fuel to the burners automatically. Additionally one high water level alarm is to be fitted on the secondary circuit which may be operated by the same detector as that provided for low water level detection.
2. Only one independent system of low water level detection, alarm and automatic oil fuel shut off need be fitted in the case of small forced circulation or re-circulation coiled water tube 'package' type boilers when evaporation is less than 2900 kg/hr or the heating surface is less than 100 m^2.
3. Where two level sensors are provided these may be used for other functions, e.g. high level alarm, level control, trip systems. etc.
4. For boilers not supplying steam for propulsion or for services essential for the safety or the operation of the ship at sea, only the items marked* are required.
5. These safeguards are to remain operative during automatic, manual and emergency operation.
6. For exhaust gas economisers/boilers requiring feed water or forced water circulation, the low flow alarm is to be fitted with provision to override the alarm if the exhaust gas economiser/boiler is to be operated in the dry condition. *See also* Pt 7, Ch 3,6.2.4.
7. Alternatively, details (including location) of an appropriate fire detection system are to be submitted for consideration.

Volume 2, Part 9, Chapter 1
Control Engineering Systems

Effective date 1 January 2011

■ *Section 1*
General engineering systems

1.1 General requirements

1.2.5 **Programmable electronic systems.** (In addition to the documentation required by 1.2.2.):

- System requirements specification.
- Details of the hardware configuration in the form of a system block diagram, including input/output schedules.
- Details of ~~power supply and~~ data storage arrangements, *see* 2.10.9 and 2.12.6.
- Hardware certification details, *see* 2.10.5 and 2.12.3.
- Software quality plans, including applicable procedures, *see* 2.10.21.
- Factory acceptance, integration, harbour and sea trial test schedules for hardware and software.
- System integration plan, *see* 2.13.2.
- Failure Mode and Effects Analysis (FMEA), *see* 2.13.5.

Volume 2, Part 10, Chapter 1
Electrical Engineering

Effective date 1 January 2011

■ *Section 1*
General requirements

1.2 Plans

1.2.6 A schedule of electrical equipment ~~located in hazardous areas~~ for use in explosive gas atmospheres or in the presence of combustible dusts giving details, as appropriate, of:

(a) type of equipment;
(b) type of protection, e.g. Ex 'd';
(c) apparatus group, e.g. IIB;
(d) temperature class, e.g. T3;
(e) enclosure ingress protection, e.g. IP55;
(f) certifying authority;
(g) certificate number;
(h) location of equipment.

Details may be included on arrangement drawings for the hazardous locations, in place of a separate schedule. Where uncertified equipment is permitted by 13.2 or 13.3 or the Rules relevant to the specific type of ship, details of other documentation confirming (b) to (d) may be submitted in place of those listed under (f) and (g).

1.2.8 Details of electrically operated fire, ship, crew and embarked personnel emergency safety systems which are to include typical single line diagrams and arrangements, showing main vertical and, where applicable, horizontal fire zones, spaces along the ship bottom that are not fitted with a double bottom and the location of equipment and cable routes, including identification of relevant areas of high fire risk, to be employed for:

(a) emergency lighting;
(b) accommodation fire detection, alarm and extinction systems;
(c) fixed water-based local application fire-fighting systems;
(d) public address system;
(e) general alarm;
(f) watertight doors, bow, stern and shell doors and other electrically operated closing appliances; and
(g) low location lighting.

NOTE

A general arrangement plan of the complete ship showing the main vertical fire zones, spaces along the ship bottom that are not fitted with a double bottom and the location of equipment and cable routes, including identification of relevant areas of high fire risk, for the above systems, is to be made available for the use of the Surveyor on board.

1.12 Earthing of non-current carrying parts

1.12.1 Except where exempted by 1.12.2, all non-current carrying exposed metal parts of electrical equipment and cables are to be earthed for ~~personal~~ personnel protection against electric shock. Bonding is to give a substantially equal potential and a sufficiently low earth fault loop impedance to ensure correct operation of protective devices.

1.12.3 ~~Extraneous-conductive parts (i.e. parts not forming part of the electrical installation and liable to introduce an electric potential) which are connected to the ship's hull by permanent and reliable metal-to-metal joints of negligible impedance that will not be affected by vibration and shock as arise in normal practice need not be bonded by separate earthing conductors.~~ Where extraneous-conductive parts (i.e. parts not forming part of the electrical installation and liable to introduce an electric potential) are not bonded by separate earthing conductors, details are to be submitted that demonstrate that a permanent, metal-to-metal connection of negligible impedance, which will not degrade due to corrosion or vibration, will be achieved.

1.12.4 Armouring, braiding and other metal coverings of cables are to be effectively earthed. Where the armouring, braiding and other metal coverings are earthed at one end only, they are to be adequately protected and insulated at the unearthed end with the insulation being suitable for the maximum voltage that may be induced. *See* 13.8.3 for earthing of cables in ~~dangerous~~ hazardous zones or spaces.

1.15 Operation under flooding conditions

1.15.1 Flooding of spaces along the ship bottom that are not fitted with a double bottom is not to result in the loss of the ability to provide electrically operated fire, ship, crew and embarked personnel emergency safety systems outside of the spaces.

1.15.2 Installation of electrical equipment necessary to provide fire, ship, crew and embarked personnel emergency safety systems in spaces along the ship bottom not fitted with a double bottom is to be avoided, wherever practical. Where it is proposed to install electrical equipment, including cabling, necessary to provide fire, ship, crew and embarked personnel emergency safety systems in such spaces, evidence is to be submitted to demonstrate that required emergency services will be available in other spaces in the event of flooding of the space not fitted with a double bottom.

Existing sub-Sections 1.15 to 1.18 *are to be renumbered* 1.16 to 1.19.

■ *Section 3*
Emergency and alternative source of electrical power

3.2 Emergency source of electrical power

3.2.9 The transitional source of emergency electrical power required by 3.2.8 is to consist of an accumulator battery suitably located for use in an emergency which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage and be of sufficient capacity and so arranged as to supply automatically in the event of failure of either the main or emergency source of electrical power for half an hour at least the following services, if they depend upon an electrical source for their operation:

~~(a) for half an hour:~~

~~(i)~~ (a) the lighting required by 3.2.7(a) and (b);

~~(ii)~~ (b) all services required by 3.2.7(c)(i), (iii) and (iv) unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.

~~(iii)~~ (c) Where connected, the supplementary lighting required by 3.2.16.

~~(b)~~ (d) Power to operate the watertight doors at least three times, i.e. closed-open-closed against an adverse list of 15°, but not necessarily all of them simultaneously, together with their control, indication and alarm circuits as required by 3.2.7(f)(i).

■ *Section 5*
Supply and distribution

5.1 Systems of supply and distribution

5.1.2 For oil supply ships intended for the carriage in bulk of oil and other hazardous liquids having a flash point not exceeding 60°C (closed-cup test) only the following systems of generation and distribution are acceptable:

(a) d.c., two-wire insulated;

(b) a.c., single-phase, two-wire, insulated;

(c) a.c., three-phase, three-wire, insulated;

(d) earthed systems, a.c. or d.c., limited to areas outside any dangerous space or zone, and arranged so that no current arising from an earth-fault in any part of the system could pass through a dangerous space or zone. Earthed intrinsically safe circuits are permitted to pass into and through dangerous spaces and zones.

Existing paragraphs 5.1.2 to 5.1.6 *are to be renumbered* 5.1.3 to 5.1.7.

■ *Section 6*
Systems design – Protection

6.8 Protection of generators

6.8.7 The protection of electrical power generation and distribution systems is to be so arranged that, in the event of failure of a protection device, including integrated multifunction relays, sufficient power can be supplied to all essential services, *see also* 5.2.4.

6.8.8 It is to be possible to control the generator prime mover in the event of failure of an electrical system protection device.

■ *Section 7*
Switchgear and control gear assemblies

7.11 Instruments for alternating current generators

7.11.4 The indicators and displays required by 7.11.1 to 7.11.3 are to be located and arranged such that they are viewable at a single operating position. Where manual paralleling is provided, it is to be possible to adjust voltage and frequency at this position.

Existing paragraph 7.11.4 *is to be renumbered* 7.11.5.

■ *Section 9*
Converter equipment

9.1 Transformers

9.1.12 The following tests are to be carried out on all transformers at the manufacturer's works, and a certificate of tests issued by the manufacturer, *see also* 1.3.2 and 1.3.3:

(a) measurement of winding resistances, voltage ratio, impedance voltage, short-circuit impedance, insulation resistance, load loss, no load loss and current;
(b) dielectric tests;
(c) temperature rise test on one transformer of each size and type~~.~~ ; and
(d) where evidence of compliance with 9.1.9 is not submitted for consideration, short-circuit withstand on one transformer of each size and type.

■ *Section 10*
Electric cables and busbar trunking systems (busways)

10.8 Installation of electrical cables

10.8.8. ~~Adequate protection~~ Protection is to be provided for cable oversheaths in areas where cables are likely to be exposed to damaging substances under normal circumstances or areas where the spillage or release of harmful substances is likely.

10.9 Mechanical protection of cables

~~*10.9.3* Non-metallic protective casings and fixings are to be flame retardant in accordance with the requirements of IEC 60092-101.~~

Existing paragraph 10.9.4 *is to be renumbered* 10.9.3.

10.10 Cable support systems

~~*10.10.5* Where the cable support system or fixings are manufactured from a material other than metal, suitable supplementary metallic fixings or straps spaced at regular distances are to be provided, such that, in the event of a fire or failure, the cable support system and the cables affixed to it are prevented from falling and causing an injury to personnel and/or an obstruction to any escape route. Alternatively, the cables may be routed away from such areas.~~

Existing paragraph 10.10.6 *is to be renumbered* 10.10.5.

10.11 Penetration of bulkheads and decks by cables

10.11.1 Where electric cables pass through watertight, fire insulated or gastight bulkheads or decks separating ~~dangerous~~ hazardous zones or spaces from ~~non-dangerous~~ non hazardous zones or spaces, the arrangements are to be such as to ensure the integrity of the bulkhead or deck is not impaired. The arrangements chosen are to ensure that the cables are not adversely affected.

10.12 Installation of electric cables in protective casings

~~*10.12.2* When protective casings are secured by means of clips or straps manufactured from a material other than metal the fixings are to be supplemented by suitable metal clips or straps spaced at regular distances each not exceeding 2 m.~~

Existing paragraphs 10.12.3 *to* 10.12.8 *are to be renumbered* 10.12.2 *to* 10.12.7.

10.13 Non metallic cable support systems, protective casings and fixings

10.13.1 Where it is proposed to use non metallic cable support systems, protective casings or fixings, the additional requirements of this sub-Section apply. Non metallic protective cases are not permitted where 10.8.14(b) applies.

10.13.2 Non metallic cable support systems and protective casings are to be installed in accordance with the manufacturer's recommendations. The support systems and protective casings are to have been tested in accordance with an acceptable test procedure for:

(a) ambient operating temperatures;
(b) safe working load;
(c) impact resistance;
(d) flame retardancy;
(e) smoke and toxicity; and

(f) use in explosive gas atmospheres or in the presence of combustible dusts, electrical conductivity;

with satisfactory results.

10.13.3 Non metallic cable support systems, protective casings and fixings installed on the open deck are to be protected from degradation caused by exposure to solar radiation.

10.13.4 Where the cable support system, protective casing or fixings are manufactured from a material other than metal, suitable supplementary metallic fixings or straps spaced at regular distances are to be provided such that, in the event of a fire or failure, the cable support system, protective casing and the affixed cables are prevented from falling and causing an injury to personnel and/or an obstruction to any escape route. Alternatively, the cables may be routed away from such areas.

10.13.5 The load on non metallic cable support systems or protective casings is not to exceed the tested safe working load.

10.13.6 When a cable support system or protective casing is secured by means of clips or straps manufactured from a material other than metal, the fixings are to be supplemented by suitable metal clips or straps spaced at regular distances each not exceeding 2 m and, for non metallic cable support systems or protective casings, that used during safe working load testing.

10.13.7 Non metallic fixings are to be flame retardant in accordance with the requirements of IEC 60092-101, or an alternative, relevant National or International Standard.

Existing sub-Sections 10.13 *to* 10.17 *are to be renumbered* 10.14 *to* 10.18.

■ *Section 11*
Batteries

11.3 Location

11.3.9 Only electrical equipment necessary for operational reasons and for the provision of lighting is to be installed in compartments provided in compliance with 11.3.1, the compartment ventilation exhaust ducts and zones within a 1,5 m radius of the ventilation outlet(s). Such electrical equipment is to be certified for group IIC gases and temperature Class T1 in accordance with IEC 60079: *Electrical apparatus for explosive gas atmospheres*, or an acceptable and relevant National Standard.

■ *Section 13*
Electrical equipment for use in explosive gas atmospheres or in the presence of combustible dusts

13.1 General

13.1.4 Equipment that is to be installed in an area where both explosive gases and combustible dusts can be present is to be selected in accordance with both 13.2 and 13.3.

13.1.5 For permanent secondary battery installations, *see* Section 11.

13.2 Selection of equipment for use in explosive gas atmospheres

13.2.1 When apparatus is to be installed in areas where an explosive gas atmosphere may be present, unless permitted otherwise by 13.2.2, it is to be of a 'safe-type', as listed below, certified or approved by a competent authority for the gases encountered. The construction and type testing is to be in accordance with IEC 60079: Electrical Equipment for Explosive Gas Atmospheres or an acceptable and relevant National Standard.

Intrinsically safe – Ex 'i'
Increased safety – Ex 'e'
Flameproof – Ex 'd'
Pressurised enclosure – Ex 'p'
Powder filled – Ex 'q'
Encapsulated – Ex 'm'
Special – Ex 's'.

13.2.2 Consideration may be given to the use of equipment of the following types:

(a) equipment such as control panels, protected by purging and pressurisation and capable of being verified by inspection as meeting the requirements of IEC 60079-2;
(b) simple non-energy-storing apparatus having negligible surface temperature rise in normal operation, such as limit switches, strain gauges, etc, incorporated in intrinsically-safe circuits;
(c) radio aerials having robust construction, meeting the relevant requirements of IEC 60079-15. Additionally, in the case of transmitter aerials, it is to be shown, by detailed study or measurement, or by limiting the peak radiated power and field strength to 1 W and 30 V/m, respectively, that they present negligible risk of inducing incendive sparking in adjacent structures or equipment;
(d) electrical apparatus with type of protection 'n' or 'N' provided it is in a well ventilated area on open deck and not within 3 m of any flammable gas or vapour outlet.

13.2.3 Where apparatus is to be installed in areas where combustible dusts may be present in quantities sufficient to create an explosive atmosphere, it is, when practicable, to be of a type certified or approved by a competent authority for the dusts and additionally any explosive gases encountered.

13.2.1 When equipment is to be installed in areas where an explosive gas atmosphere may be present it is generally to be of a type providing protection against ignition of the gases encountered and compliant with the relevant Parts of IEC 60079, *(Electrical Apparatus for) Explosive Gas Atmospheres*, or an acceptable and relevant National Standard or Navy Standard, unless permitted otherwise by 13.2.4, 13.2.5 or 13.2.6.

13.2.2 The equipment protection type permitted depends on the hazardous zone where the equipment is to be located, as defined in 13.5. For certain locations on the ship other requirements may limit installations to specific equipment types and/or particular applications.

13.2.3 Equipment for **zone 0** or **zone 1**, with the exception of simple apparatus as defined in 13.2.4 or 13.2.5, is to be certified or approved by a National or other appropriate Authority. Equipment without independent certification or approval may be considered for installation in **zone 2**.

13.2.4 In **zone 0**, the following may be considered:
(a) intrinsically safe, category 'a' (Ex 'ia'); or
(b) simple electrical apparatus and components (for example thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically safe circuits of category 'ia', not capable of storing or generating electrical power or energy in excess of the limits given in IEC 60079-14, *Explosive atmospheres: Electrical installations design, selection and erection*.

13.2.5 In **zone 1**, the following may be considered:
(a) apparatus permitted within **zone 0**;
(b) intrinsically safe, category 'b' (Ex 'ib');
(c) simple apparatus as defined above, included in intrinsically safe circuits of category 'ib';
(d) increased safety (Ex 'e');
(e) flameproof (Ex 'd');
(f) pressurised enclosure (Ex 'p');
(g) powder filled (Ex 'q'); or
(h) encapsulated (Ex 'm');
(j) Special – Ex 's', where permitted by the equipment certification.

13.2.6 In **zone 2**, the following may be considered:
(a) apparatus permitted within **zone 0** or **zone 1**;
(b) type of protection 'n' or 'N';
(c) equipment such as control panels, protected by purging and pressurisation and capable of being verified by inspection as meeting the requirements of IEC 60079-2; or
(d) radio aerials having robust construction, meeting the relevant requirements of IEC 60079-15. Additionally, in the case of transmitter aerials, it is to be shown, by detailed study or measurement, or by limiting the peak radiated power and field strength to 1 W and 30 V/m, respectively, that they present negligible risk of inducing incendive sparking in adjacent structures or equipment.

13.2.7 Apparatus having type of protection 'ia', 'ib', or 'd', is to be of a Group (IIA, IIB or IIC) meeting or exceeding that required for safe operation in the presence of any gas or vapour that can be present, or is to be certified specifically for such gases or vapours.

13.2.8 All apparatus is to be of a temperature classification (T1 to T6) that confirms, or is to be assessed so as to confirm, that its maximum surface temperature will not reach the ignition temperature of any gas or vapour, or mixture of gases or vapours, which can be present. The surface temperature considered may be that of an internal or external part, according to the type of protection of the apparatus.

13.3 Selection of equipment for use in the presence of combustible dusts

13.3.1 Where apparatus is to be installed in **hazardous areas**, as defined by 13.5.3, associated with the presence of combustible dusts, it is, when practicable, to be of a type certified or approved by a National or other appropriate Authority for the dusts and, additionally, any explosive gases encountered.

~~*13.2.4*~~ *13.3.2* Electrical equipment for use in ~~combustible dust atmospheres~~ such **hazardous areas** is to be so designed and installed as to minimise the accumulation of dust which may interfere with the safe dissipation of heat from the enclosure.

13.3.3 Where apparatus is to be installed in **extended hazardous areas**, as defined by 13.5.3, associated with the presence of combustible dust, the following may be considered:
(a) apparatus permitted within a hazardous area associated with the combustible dust(s) that can be present;
(b) apparatus having degree of protection IP5X, or better, and having a surface temperature under normal operating conditions not exceeding the auto-ignition temperature of the dust(s) that can be present; and
(c) apparatus of a type which ensures absence of sparks or arcs and hot spots during normal operation.

~~*13.2.5*~~ *13.3.4* Where equipment certified for combustible dusts is not available, consideration will be given to the use of apparatus complying, as a minimum, with the following requirements, provided no explosive gases will be present:
(a) the enclosure is to be at least dust protected (IP5X) having, when type tested, an ingress of fine dust within the enclosure not exceeding 10 g per m^3 of free air space; and
(b) the surface temperature of the apparatus, under the most onerous combination of normal operating conditions, but in the absence of a dust layer, is ~~to be at least 10°C below the auto-ignition temperature of the dusts encountered~~ not to exceed two-thirds of the minimum ignition temperature in degrees Celsius of the dust/air mixture(s) that can be present; or
(c) the equipment is to be certified intrinsically safe having a temperature classification ensuring compliance with (b), or
(d) pressurised and operated in accordance with procedures ensuring, prior to its re-energisation, the absence of dust within the enclosure following loss of pressurisation and consequent shutdown, and having surface temperature complying with (b); or
(e) simple apparatus included in intrinsically safe circuits or radio aerials, complying with ~~13.2.2(b) or (c)~~ 13.2.4, 13.2.5 or 13.2.6 respectively.

13.3.5 Consideration may also be given to arrangements complying with IEC 60092-506, *Electrical Installation in Ships – Special Features – Ships carrying specific dangerous goods and materials hazardous only in bulk*.

Existing sub-Sections 13.3 *to* 13.9 *are to be renumbered* 13.4 *to* 13.10.

~~13.3~~ 13.4 Installation of electrical equipment

~~*13.3.1*~~ *13.4.1* The method of installation and application of ~~safe-type~~ electrical equipment suitable for use in explosive gas atmospheres or in the presence of combustible dusts is to be in accordance with IEC 60079-14, or the National Code of Practice relevant to the Standard ~~to which the equipment has been certified~~ with which the equipment complies. Any special requirements laid down by the equipment certification documentation are also to be observed. The ambient temperature range for which the apparatus is certified is to be taken to be –20°C to 40°C, unless otherwise stated, and account is to be taken of this when assessing the suitability of the equipment for the auto-ignition temperature of the gases and dusts encountered.

~~*13.3.2*~~ *13.4.2* All switches and protective devices from which equipment located in ~~dangerous~~ hazardous zones or spaces is supplied are to interrupt all poles or phases and, where practicable, are to be located in a non hazardous zone or space. Such equipment, switches and protective devices are to be suitably labelled for identification purposes.

~~13.4 Dangerous zones and spaces~~

13.4.2 A dangerous zone or space may arise from the presence of any of the following:

(a) spaces or tanks containing either:
  (i) flammable liquid having a flashpoint (closed-cup test), not exceeding 60°C;
  (ii) flammable liquid having a flashpoint exceeding 60°C, heated or raised by ambient conditions to a temperature within 15°C of its flashpoint;
  (iii) flammable gas.

(b) piping systems or equipment containing fluid defined by (a) and having flanged joints or glands or other openings through which leakage of fluid may occur under normal operating conditions;

(c) spaces containing solids, such as coal or grain, liable to release flammable gas and/or combustible dust;

(d) piping systems or equipment associated with processes (such as battery charging or electrochlorination) generating flammable gas as a by-product and having openings from which the gas may escape under normal operating conditions;

(e) piping systems or equivalent containing flammable liquids not defined by (a), having flanged joints, glands or other openings through which leakage of fluid in the form of a mist or fine spray may occur under normal operating conditions.

13.4.3 The following zones or spaces are regarded as dangerous:

(a) the interiors of those spaces, tanks, piping systems and equipment defined by 13.4.2(a), (b) and (c);

(b) spaces separated by a single bulkhead or deck from a cargo defined by 13.4.2(a);

(c) enclosed or semi-enclosed spaces containing pipework or equipment defined by 13.4.2(b) and (d);

(d) enclosed or semi-enclosed spaces with direct opening into a dangerous space or zone;

(e) zones within a 3 m radius of ventilation inlets or outlets, hatches or doorways or other openings into dangerous spaces, or within 3 m of the ventilation outlets of spaces regarded by 13.6 as open areas and which contain the pipework or equipment defined by 13.4.2(b); where the hazard results from flammable gas or vapour having a density relative to that of air of more than 0,75, the dangerous zone is considered to extend vertically downward to solid deck, or for a distance of 9m, whichever is the lesser;

(f) zones within a 3 m radius of flanged joints, or glands or other openings defined by 13.4.2(b); in the case of gas or vapour having a relative density of more than 0,75, the dangerous zone is considered to extend vertically downwards as described under (e);

(g) zones within a 1,5 m radius of the ventilation outlets of spaces regarded as open areas containing items defined under 13.4.2(d):

(h) zones within a 1,5 m radius of flanged joints, or glands or other openings defined by 13.4.2(d) and (e);

(j) zones within a 3 m radius of bunds or barriers intended to contain spillage of liquids defined by 13.4.2(a).

13.5 Hazardous zones and spaces

~~*13.4.1*~~ *13.5.1* For ~~dangerous~~ hazardous zones or spaces and sources of hazard for naval ships, the following principles are to apply in general.

13.5.2 Hazardous areas associated with flammable liquids or gases are classified into zones based upon the frequency of the occurrence and duration of an explosive gas atmosphere, as follows:

- **zone 0**: place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously or for long periods or frequently;
- **zone 1**: place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally;
- **zone 2**: place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

See IEC 60079-10, *Electrical apparatus for explosive gas atmospheres: Classification of hazardous areas.*

13.5.3 Hazardous areas associated with solid substances or packaged liquids are classified into zones based upon the frequency of the occurrence and duration of an explosive atmosphere due to the presence of gas and/or dust, as follows:

- **hazardous area**: area in which an explosive atmosphere is likely to occur in normal operation (comparable with **zone 1**)

- **extended hazardous area**: area in which an explosive atmosphere is not likely to occur in normal operation and, if it does occur, is likely to do so only infrequently and will exist for a short period only (comparable with **zone 2**).

See IEC 60079-10-2, *Explosive atmospheres: Classification of areas – Combustible dust atmospheres, or IEC 60092-506, Electrical Installation in Ships – Special Features – Ships carrying specific dangerous goods and materials hazardous only in bulk*. An explosive atmosphere may exist due to gas and/or dust.

13.5.4 A hazardous zone or space may arise from the presence of any of the following:

(a) spaces or tanks containing either:
  (i) flammable liquid having a flashpoint (closed-cup test) not exceeding 60°C;
  (ii) flammable liquid having a flashpoint exceeding 60°C, heated or raised by ambient conditions to a temperature within 15°C of its flashpoint; or
  (iii) flammable gas;
(b) piping systems or equipment containing fluid defined by (a) and having flanged joints or glands or other openings through which leakage of fluid may occur under normal operating conditions;
(c) spaces containing solids, such as coal or grain, liable to release flammable gas and/or combustible dust;
(d) spaces containing dangerous goods in packaged form, of the following Classes as defined in the IMDG Code: 1 (with the exception of goods in division 1.4, compatibility group S), 2.1 (inclusive of applicable gas bottles for on board use), 3, 6.1 and 8;
(e) piping systems or equipment associated with processes (such as electrochlorination) generating flammable gas as a by-product and having openings from which the gas may escape under normal operating conditions; or
(f) piping systems or equivalent containing flammable liquids not defined by (a), having flanged joints, glands or other openings through which leakage of fluid in the form of a mist or fine spray may occur under normal operating conditions.

13.5.5 The following zones or spaces are regarded as hazardous, **zone 0**:

(a) the interiors of those spaces, tanks, piping systems and equipment defined by 13.5.4(a) and (b); and
(b) enclosed, unventilated spaces containing pipework or equipment defined by 13.5.4(b) and (e).

13.5.6 The following zones or spaces are regarded as hazardous, **zone 1**:

(a) the interiors of spaces containing dangerous goods as defined by 13.5.4(d);
(b) unventilated spaces separated by a single bulkhead or deck from a cargo defined by 13.5.4(a);
(c) ventilated spaces containing pipework or equipment defined by 13.5.4(b) and (e);
(d) zones within a 1,5 m radius of ventilation outlets, hatches or doorways or other openings into spaces defined by (a), (b) or (c), or within 1,5 m of the ventilation outlets of spaces regarded by 13.7 as open areas and which contain the pipework or equipment defined by 13.5.4(b) or (e). Where the hazard results from flammable gas or vapour having a density relative to that of air of more than 0,75 m, the hazardous zone is considered to extend vertically downward to solid deck, or for a distance of 9 m, whichever is the lesser;
(e) zones within a 1,5 m radius of flanged joints, or glands or other openings defined by 13.5.4(b); in the case of gas or vapour having a relative density of more than 0,75 m, the hazardous zone is considered to extend vertically downwards as described under (d);
(f) zones within a 1,5 m radius of flanged joints, or glands or other openings defined by 13.5.4(e) and (f);
(g) zones within a 1,5 m radius of bunds or barriers intended to contain spillage of liquids defined by 13.5.4(a);
(h) zones on open deck within a 1,5 m radius of any opening into a space defined by (a) or (b; and
(j) enclosed or semi-enclosed spaces with direct opening into a **zone 1** hazardous location.

13.5.7 The following zones or spaces are regarded as hazardous, **zone 2**:

(a) ventilated spaces separated by a single bulkhead or deck from a **zone 0** space;
(b) zones on open deck extending 1,5 m beyond those defined by 13.5.6(d), (e), (f), (g) or (h);
(c) zones within a 1,5 m radius of ventilation inlets serving spaces defined by 13.5.6(a) or (c); and
(d) enclosed or semi-enclosed spaces with direct opening into a **zone 2** hazardous location.

~~13.6~~ 13.7 Ventilation

~~*13.6.1*~~ *13.7.1* Where an enclosed or semi-enclosed space is provided with mechanical ventilation ensuring at least 12 air changes/hour, and leaving no areas of stagnant air, it may be regarded in consideration of ~~dangerous~~ hazardous zones as would otherwise be defined by ~~13.4.3 (c) and (d)~~ 13.5.5(b), 13.5.6(e) or (j) and 13.5.7(d), as an open area.

~~*13.6.2*~~ *13.7.2* Where the rate of ventilation air flow, in relation to the maximum rate of release of flammable substances reasonably to be expected under normal conditions, is sufficient to prevent the concentration of flammable substances approaching their lower explosive limit, consideration may be given to regarding as ~~non-dangerous~~ non hazardous, the space, ventilation and other openings into it, and the zone around the equipment contained within.

Existing paragraph 13.6.3 *is to be renumbered* 13.7.3.

~~13.7~~ 13.8 Pressurisation

~~*13.7.1 A space having access to a dangerous space or*~~ zone as defined under 13.4.3(c) to (j) may be regarded as non-dangerous if fulfilling all the following conditions:

(a) access is by means of an air-lock, having gastight steel doors, the inner of which as a minimum, is self-closing without any hold-back arrangement;

~~(b) it is maintained at an overpressure relative to the external hazardous area by ventilation from a non-dangerous area;~~
(c) the relative air pressure within the space is continuously monitored and, so arranged, that in the event of loss of overpressure an alarm is given and the electrical supply to all equipment not of a safe-type is automatically disconnected. Where the shutdown of equipment could introduce a hazard, an alarm may be given, in lieu of shutdown, upon loss of overpressure, and a means of disconnection of non-safe-type electrical equipment, capable of being controlled from a manned station, provided in conjunction with an agreed operational procedure; where the means of disconnection is located within the space then it is to be effected by equipment of a safe-type;
(d) any electrical equipment required to operate upon loss of overpressure, lighting fittings (see 5.7.4) and equipment within the air-lock, is to be of a safe-type;
(e) means are to be provided to prevent electrical equipment, other than of a safe-type, being energised until the atmosphere within the space is made safe, by air renewal of at least 10 times the capacity of the space.

13.8.1 A space having access to a hazardous space or zone defined as **zone 1** or **zone 2** may be regarded as non hazardous if fulfilling all the following conditions:
(a) access is by means of an air-lock, having gastight steel doors, the inner of which, as a minimum, is self-closing without any hold-back arrangement;
(b) it is maintained at an over pressure relative to the external hazardous area by ventilation from a non hazardous area;
(c) the relative air pressure within the space is continuously monitored and so arranged that, in the event of loss of over pressure, an alarm is given and the electrical supply to all equipment not of a type suitable for zone 1 is automatically disconnected. Where the shutdown of equipment could introduce a hazard, an alarm may be given, in lieu of shutdown, upon loss of over pressure, and a means of disconnection of electrical equipment not of a type suitable for **zone 1**, capable of being controlled from an attended station, provided in conjunction with an agreed operational procedure; where the means of disconnection is located within the space then it is to be effected by equipment of a type suitable for **zone 1**;
(d) any electrical equipment required to operate upon loss of over pressure, lighting fittings (*see* 5.7.3) and equipment within the air-lock, is to be of a type suitable for **zone 1**; and
(e) means are to be provided to prevent electrical equipment, other than of a type suitable for **zone 1**, being energised until the atmosphere within the space is made safe, by air renewal of at least 10 times the capacity of the space.

13.8.2 A space having access to a hazardous space or zone defined as **zone 2** may be regarded as non hazardous if fulfilling all the following conditions:
(a) access is by means of a self-closing gastight steel door without any hold-back arrangement;
(b) it is maintained at an over pressure relative to the external hazardous area by ventilation from a non hazardous area;
(c) the relative air pressure within the space is continuously monitored and so arranged that, in the event of loss of over pressure, an alarm is given. A means of disconnection of electrical equipment not of a type suitable for **zone 2** is to be provided; where the means of disconnection is located within the space then it is to be effected by equipment of a type suitable for **zone 2**;
(d) any electrical equipment required to operate upon loss of over pressure (e.g. lighting fittings, *see* 5.7.3), is to be of a type suitable for **zone 2**.

~~13.8~~ 13.9 Cable and cable installation

~~*13.8.1* In addition to the requirements of Section 10, cables for circuits that are not intrinsically safe, which are located in dangerous zones or spaces, or which may be exposed to oil, vapour or gas, are to be either:~~
~~(a) mineral insulated with copper sheath; or~~
~~(b) armoured or braided for earth detection.~~

13.9.1 Electric cables are not to be installed in hazardous zones or spaces, except when forming part of an intrinsically safe circuit or where specifically permitted elsewhere in this Section.

13.9.2 Electric cables are not, as far as is practicable, to be installed in hazardous zones or spaces, except where serving equipment installed within the zone or space. Through runs of cable may be accepted in locations classified as **zone 1** or **zone 2**, where alternative routes are impracticable.

13.9.3 In addition to the requirements of Section 10, cables for circuits that are not intrinsically safe, which are located in hazardous zones or spaces, or which may be exposed to cargo oil, oil vapour or gas, are to be either:
(a) mineral insulated with copper sheath; or
(b) armoured or braided for earth detection; or
(c) otherwise adequately protected against mechanical or chemical damage, within **zone 2** or non hazardous locations only; or
(d) as otherwise specifically permitted elsewhere within this Section.

Existing paragraphs 13.8.2 *and* 13.8.3 *are to be renumbered* 13.9.4 *and* 13.9.5.

~~*13.8.4*~~ *13.9.6* Cables associated with intrinsically safe circuits are to be used only for such circuits. They are to be physically separated from cables associated with non intrinsically safe circuits, e.g. neither installed in the same protective casing nor secured by the same fixing clip. Consideration may be given to other arrangements complying with IEC 60079-14, *Explosive atmospheres: Electrical installations design, selection and erection*.

13.9.7 In **zone 0**, cable joints may only be used in intrinsically safe circuits.

13.9.8 Cable runs in **zone 1** or **zone 2** are, where practicable, to be uninterrupted. Where discontinuities cannot be avoided, cable joints are, additionally, to:

- be made in an enclosure with a type of protection appropriate to the location; or
- provided the joint is not subject to mechanical stress, be epoxy filled, compound filled or sleeved with heat-shrunk tubing, in accordance with the manufacturer's instructions.

13.10 Requirements for Oil Supply Ships intended for the carriage in bulk of oil cargoes having a flash point not exceeding 60°C (closed-cup test)

13.10.1 In order to eliminate potential sources of ignition from hazardous areas on board Oil Supply Ships electrical equipment is to be selected and installed in accordance with IEC 60092: *Electrical installations in ships – Part 502: Tankers – Special features*.

13.10.2 The relevant group and temperature class for electrical equipment in hazardous zones are, respectively, IIA and T3.

~~13.9~~ 13.11 Special requirements for ships with spaces for carrying vehicles, helicopters and aircraft, with fuel in their tanks

(*Part only shown*)

~~*13.9.1*~~ *13.11.1* Ships with closed spaces carrying vehicles, helicopter and aircraft with fuel having a flashpoint not exceeding 60°C:

(a) except where exempted by (b) electrical equipment fitted within the space and within the exhaust ventilation, trunking for the space is to be of a ~~safe type~~ type acceptable for **zone 1**;

■ *Section 14*
Navigation and manoeuvring systems

14.5 Navigation lights

14.5.1 Navigation lights are to be connected separately to a distribution board reserved for this purpose only and accessible to the officer of the watch. This distribution board is to be connected to the emergency source of electrical power in compliance with 3.2.7(c) and 3.2.9(a). ~~Provision is to be made on the navigation bridge for the navigation lights to be transferred to an alternative circuit fed from the main source of electrical power.~~ An alarm is to be activated in the event of failure of a power supply from the distribution board.

14.5.3 Provision is to be made on the navigating bridge for the navigation lights to be transferred to an alternative circuit fed from the main source of electrical power. Where there is no dedicated emergency source of electrical power because there are two or more main electrical power sources as permitted by 3.1.3, the navigation light panel is to be connected to at least two sources of power with arrangements to transfer between the two sources.

Existing paragraphs 14.5.3 *to* 14.5.5 *are to be renumbered* 14.5.4 *to* 14.5.6.

~~*14.5.6* Where there is no dedicated emergency source of electrical power because there are two or more main electrical power sources as permitted by 3.1.3, the navigation light panel is to be connected to at least two sources of power with arrangements to transfer between the two sources.~~

14.5.7 Navigation light power supply units installed to convert, control and/or monitor the distribution board power supply required by 14.5.1 above for connection to the light source(s) (e.g. for LED type navigation lights) are, in the event of a short-circuit on the unit output, to disconnect or limit the supply to prevent further damage and activate an alarm.

14.5.8 Navigation light power supply units are to be self-monitoring, detecting failures of the unit itself and activating an alarm. These are to include:

- detection of system lock-ups (program hangs);
- means to detect failure of navigation light switching command input circuits or links; and
- means to detect failure of the navigation light monitoring arrangements required to provide the alarms required by 14.5.4 and 14.5.5, as applicable.

14.5.9 The navigation light power supply failure alarms required by 14.5.1 are not to be displayed as a group alarm. Other navigation light alarms may be grouped for each navigation light where means are provided for personnel to determine the cause of the alarm. Activation of more than one of the navigation light alarms as a result of a single failure is to be prevented.

Existing paragraph 14.5.7 *is to be renumbered* 14.5.10.

Volume 2, Part 11, Chapter 1
Made and Fresh Water Systems

Effective date 1 January 2011

■ *Section 1*
General requirements

1.3 Plans and information

1.3.2 **Design statement**. A design statement of the made and fresh water system ~~that details system capability and functionality under defined operating and emergency conditions within the normal concept of operation role of the ship. The design statement is to be agreed between Designers and Owners/Operators~~. *See* Pt 1, Ch 2,3.2.2(c) and 3.1.1, 3.2.2, 3.2.3, 3.3.2, 3.4.2, 3.4.6 and 5.3.1 for specific references to the design statement.

Volume 2, Part 11, Chapter 2
Heating, Ventilation and Cooling Arrangements

Effective date 1 January 2011

■ *Section 1*
General requirements

1.3 Plans and information

1.3.2 **Design statement**. A design statement of the HVAC systems ~~that details system capability and functionality under defined operating and emergency conditions within the normal concept of operation role of the ship. The design statement for HVAC arrangements for the ship is to be agreed between the Designer and Owner/Operator~~. *See* Pt 1, Ch 2,3.2.2(c) and 2.4.1, 2.5.1, 2.6.1, 3.1.2(d), 3.1.4, 3.3.1, 3.6.1 and 5.3.1 for specific references to the design statement.

Volume 2, Part 11, Chapter 3
Waste Systems

Effective date 1 January 2011

■ *Section 1*
General requirements

1.3 Plans and information

1.3.2 **Design statement**. A design statement of the waste systems ~~that details system capability and functionality under defined operating and emergency conditions within the normal concept of operation role of the ship. The design statement for waste arrangements for the ship is to be agreed between the Designer and Owner/Operator~~, *see* Pt 1, Ch 2,3.2.2(c).

~~Volume 3, Part 1 Chapter 3~~
~~Dynamic Positioning Systems~~

Effective date 1 January 2011

~~■ *Section 1*~~
General

1.1 Application

1.1.1 The requirements of this Chapter apply to naval ships with installed dynamic positioning systems and are additional to those applicable in other Parts of these Rules.

1.1.2 A ship provided with a dynamic positioning system in accordance with these Rules will be eligible for an appropriate class notation.

1.1.3 Requirements, additional to these Rules may be imposed by the Naval Authority.

1.1.4 For the purpose of these Rules, dynamic positioning means the provision of a hydro-dynamic system with automatic and/or manual control capable of maintaining the heading and position of the ship during operation within specified limits and environmental conditions.

1.1.5 For the purpose of these Rules, the area of operation is the specified allowable position deviation from a set point, *see* 1.3.2.

1.1.6 Special consideration will be given where the dynamic positioning system is used primarily for purposes ~~other than position keeping, e.g. track following.~~

~~1.2 Classification notations~~

1.2.1 Ships complying with the requirements of this Chapter will be eligible for one of the following class notations, as defined in Vol 1, Pt 1, Ch 2:

DP(CM) *See* Section 2.
DP(AM) *See* Section 3.
DP(AA) *See* Section 4.
DP(AAA) *See* Section 5.

1.2.2 The class notation may be supplemented with a Performance Capability Rating (PCR). This rating indicates the calculated percentage of time that a ship is capable of maintaining heading and position under a standard set of environmental conditions (North Sea). *See* Section 6.

1.2.3 Where a **DP** notation is not requested, dynamic positioning systems are to be installed in accordance with the requirements of Section 2 as far as is practicable.

1.3 Information and plans required to be submitted

1.3.1 The information and plans specified in 1.3.2 to 1.3.7 are to be submitted in triplicate. The Operation Manuals specified in 1.3.8 are to be submitted in a single set.

1.3.2 Details of the limits of the area of operation and heading deviations together with proposals for redundancy and segregation provided in the machinery, electrical installations and control systems are to be submitted. These proposals are to take account of the possible loss of performance capability should a component fail or in the event of ~~fire or flooding, *see also* 1.3.6 and Sections 4 and 5.~~

1.3.3 Where a common power source is utilised for thrusters, details of the total maximum load required for dynamic positioning are to be submitted.

1.3.4 Plans of the following together with particulars of ratings in accordance with the relevant Parts of the Rules are to be submitted for:
(a) Prime movers, gearing, shafting, propellers and thrusters.
(b) Machinery piping systems.
(c) Electrical installations.
(d) Pressure vessels for use with dynamic positioning system.

1.3.5 Plans of control, alarm and safety systems including the following are to be submitted:
(a) Functional block diagrams of the control system(s).
(b) Functional block diagrams of the position reference systems and the environmental sensors.
(c) Details of the electrical supply to the control system(s) the position reference system(s) and the environmental sensors.
(d) Details of the monitoring functions of the controllers, sensors and reference systems together with a description of the monitoring functions.
(e) List of equipment with identification of the manufacturer, type and model.
(f) Details of the control stations, e.g. control panels and consoles, including the location of the control stations.
(g) Test schedules (for both factory acceptance and sea trials) that are to include the methods of testing and the test facilities provided.

1.3.6 For assignment of **DP(AA)** or **DP(AAA)** notation, a Failure Mode and Effects Analysis (FMEA) is to be submitted, demonstrating that adequate segregation and redundancy of the machinery, the electrical installation and the control systems have been achieved in order to maintain position in the event of keeping capability in the event of equipment failure (*see* Section 4); or fire or flooding (*see* Section 5). The FMEA is to take a formal and structured approach and is to be performed in accordance with an acceptable and relevant National or International Standard, e.g. IEC 60812.

1.3.7 The following information is to be submitted for assignment of a PCR:
(a) Lines plan.
(b) General arrangement.
(c) Details of thruster arrangement.
(d) Thruster powers and thrusts.

1.3.8 Operation Manuals, including details of the dynamic positioning system operation, installation of equipment, maintenance and fault finding procedures, together with a section on the procedure to be adopted in emergency, are to be submitted. A copy of the manual is to be placed and retained on board the ship.

Section 2
Class notation DP(CM)

2.1 General

2.1.1 For assignment of **DP(CM)** notation the requirements of 2.1.2 and 2.2 to 2.4 are to be complied with.

2.1.2 Control engineering systems, electrical and piping installations and machinery items are to be designed, constructed, installed and tested in accordance with the relevant requirements of Vol 2, Parts 7, 9 and 10.

2.2 Thrusters

2.2.1 Thruster installations are to be designed, constructed, installed and tested in accordance with the requirements of Vol 2, Pt 4, Ch 3, as applicable.

2.2.2 Thruster installations are to be designed to minimise potential interference with other thrusters, sensors, hull or other surfaces which could be encountered in the service for which the ship is intended.

2.2.3 Thruster intakes are to be located at sufficient depth to reduce the possibility of ingesting floating debris and vortex formation.

2.2.4 The response and repeatability of thrusters to changes in propeller pitch or propeller speed/direction of rotation are to be suitable for maintaining the area of operation and heading within specified limits.

2.3 Electrical systems

2.3.1 This Section applies to the electrical generation and distribution system associated with the Dynamic Positioning System whether this generating system is dedicated to the DP system or forms a central generating arrangement for all loads on the vessel.

2.3.2 The electrical installation is to be designed, constructed and installed in accordance with the requirements of Vol 2, Pt 10, Ch 1 together with the requirements of 2.3.3 to 2.3.12.

2.3.3 Where thrusters are electrically driven, the relevant requirements, including surveys, of Vol 2, Pt 10, Ch 1,15 are to be complied with.

2.3.4 Essential services are those defined in Vol 2, Pt 10, Ch 1,1.5, as applicable, together with thruster auxiliaries, computers, generator and thruster control equipment, reference systems, environmental sensors and electrically driven thrusters.

2.3.5 The number and rating of generator sets, transformers and converter equipment are to be sufficient to ensure the operation of essential services even when one generating set, transformer or converter equipment is out of action.

2.3.6 For electrically driven thruster systems, the generator rating is to be determined by the maximum dynamic positioning load together with the maximum ancillary load.

2.3.7 There are to be arrangements to prevent overloading of the running generator(s). The tripping of non-essential loads and the temporary reduction in the load demands of electrically driven thrusters may form part of these arrangements.

2.3.8 An alarm is to be initiated when the total electrical load exceeds a preset percentage of the running generator(s) capacity. This alarm is to be adjustable between 50 and 100 per cent of the running capacity and is to be set with regard to the number of generators in service and the effect of the loss of any one generator.

2.3.9 On loss of power due to the failure of the operating generator(s) there is to be provision for the automatic starting and connection to the switchboard of a standby set and the automatic sequential restarting of essential services. Consideration may be given to cases where arrangements for automatic re-starting of thrusters would not be practicable. Details are to be submitted in such cases to show that manual means for the immediate re-starting of thrusters would be available at the control station from where the dynamic positioning system would be operated.

2.3.10 Any loads that require an uninterrupted electrical power supply are to be provided with uninterruptible power systems (UPS) having a capacity for a minimum of 30 minutes' operation following loss of the main supply. A UPS is to be provided for each control computer system.

2.3.11 An indication of the absorbed power and the available on-line generating capacity is to be provided at the main dynamic positioning control station.

2.3.12 Essential services are to be served by individual circuits. Essential services that are duplicated are:

(a) to be supplied from independent sections of their switchboard or section board;
(b) to have their circuits separated throughout their length as widely as is practicable; and
(c) not to depend upon common feeders, transformers, converters, protective devices, control circuits or control gear assemblies to operate.

2.4 Control stations

2.4.1 Control stations from which the dynamic positioning system may be operated are to be designed in accordance with sound ergonomic principles, and are to be provided with sufficient instrumentation to provide effective control and indicate that the systems are functioning correctly. Colour schemes and screen layouts are to be selected such that necessary information is readily available and clearly displayed. *See also* Vol 2, Pt 9, Ch 1,2.10 for general ergonomic requirements.

2.4.2 Control station(s) are to be located such that the operator has a good view of the ship's exterior limits and surrounding area.

2.4.3 Indication of the following is to be provided at each station from which it is possible to control the dynamic positioning system:

(a) The heading and location of the ship relative to the desired reference point or course.
(b) Vectorial thrust output, individual and total.
(c) Operational status of position reference systems and environmental sensors.
(d) Environmental conditions, e.g. wind speed and direction.
(e) Availability status of standby thrusters.

2.4.4 At least one position reference system, heading reference sensor and wind sensor are to be provided to ensure that the specified area of operation and heading can be effectively maintained.

2.4.5 Position reference systems are to incorporate measurement techniques suitable for the service conditions for which the ship is intended.

2.4.6 Where necessary for the correct functioning of a position reference system, a vertical reference sensor is to be provided to correct for the pitch and roll of the ship. There are to be at least as many vertical reference units as there are associated position reference systems.

2.4.7 Alarms, in accordance with the requirements of Vol 2, Pt 9, Ch 1,2.3, are to be provided for the following fault conditions as applicable:

(a) When the ship deviates from the area of operation.
(b) When the heading exceeds the allowable deviation.
(c) Position reference system fault (for each reference system).
(d) Heading reference sensor fault.
(e) Vertical reference sensor fault.
(f) Wind sensor fault.
(g) Taut wire excursion limit.
(h) Automatic changeover to a standby position reference system or environmental sensor.

A permanent record of the occurrences of alarms and warnings, and of status changes is to be provided.

2.5 Control system

2.5.1 A centralised remote manual control system is to be provided such that changes in the vectorial thrust output may be readily effected by a single operator action.

2.5.2 Suitable processing and comparative techniques are to be provided to validate the control system inputs from position and other sensors. Abnormal signal errors revealed by the validity checks are to operate alarms.

2.5.3 The control system for dynamic positioning operation is to be stable throughout its operational range and is to meet the specified performance and accuracy criteria.

2.5.4 Automatic controls are to be provided to maintain the heading of the ship within specified limits.

2.5.5 The allowable deviation from the desired heading is to be adjustable, but should not exceed the specified limits, *see* 1.1.4. Arrangements are to be provided to fix and identify the set point for the desired heading.

2.5.6 Alarms, in accordance with the requirements of Vol 2, Pt 9, Ch 1,2.3, are to be provided for the following fault conditions:

(a) Control computer system fault.

(b) Automatic changeover to a standby control computer system, as applicable, *see* 4.1.7.

■ *Section 3*
Class notation DP(AM)

3.1 Requirements

3.1.1 For assignment of **DP(AM)** notation, the applicable requirements of Section 2, together with 3.1.2 to 3.1.6 are to be complied with.

3.1.2 An automatic and a manual control system are to be provided and arranged to operate independently so that failure in one system will not render the other system inoperative. Arrangements for manual control are to satisfy the requirements of Section 2 when the automatic system is inoperative.

3.1.3 At least two position reference systems suitable for the intended service conditions and incorporating different measurement techniques, are to be provided and arranged so that a failure in one system will not render the other system inoperative. Special consideration will be given where the use of different techniques would not be practicable during DP operations.

3.1.4 At least two heading reference sensors and two wind sensors are to be provided and arranged so that a failure of one sensor will not render the other sensor(s) inoperative.

3.1.5 In the event of a single failure of a position reference, heading reference, or wind sensor, the control systems are to continue operating on signals from the remaining sensors without manual intervention.

3.1.6 The area of operation is to be adjustable, but is not to exceed the specified limits based on a percentage of water depth, or as applicable, a defined absolute or relative surface movement. Arrangements are to be provided to fix and identify the set point for the area of operation.

■ *Section 4*
Class notation DP(AA)

4.1 Requirements

4.1.1 For assignment of **DP(AA)** notation the applicable requirements of Sections 2 and 3, together with 4.1.2 to 4.1.10 are to be complied with.

4.1.2 Power, control and thruster systems and other systems necessary for, or which could affect, the correct functioning of the DP system are to be provided and configured such that a fault in any active component or system will not result in a loss of position. This is to be verified by means of a FMEA, *see* 1.3.6. Such components may include, but are not restricted to, the following:

Prime movers (e.g. auxiliary engines).
Generators and their excitation equipment.
Gearing.
Pumps.
Fans.
Switchgear and control gear, including their assemblies.
Thrusters.
Valves (where power actuated).

Systems which are not part of the DP system but which, in the event of a fault, could affect the correct functioning of the DP system (for example, fire suppression systems, engine ventilation systems, shutdown systems etc.) are to be included in the FMEA.

4.1.3 Cables, pipes and other components essential for correct functioning of the DP system are to be located and protected, where necessary, such that the risk of fire or mechanical damage is minimised.

4.1.4 The electrical generation and distribution arrangements are to be isolatable such that at least the minimum number of any duplicated, or otherwise replicated, items required to provide essential services would remain operational in the event of a single fault. Evidence to verify compliance with this requirement is to be submitted for consideration when required; for example, where it is intended to operate with the independent sections required by 2.3.12 connected together; or where division would be via a single circuit breaker.

4.1.5 For electrically driven thruster systems:

(a) a reduction in position keeping capability may be accepted, but this is not to result in a loss of position in the environmental conditions in which the DP system is intended to operate; and

(b) provision is to be made for the automatic starting, synchronising and load sharing of a non-running generator before the load reaches the alarm level required by 2.3.8.

4.1.6 Two automatic control systems are to be provided and arranged to operate independently so that failure in one system will not render the other system inoperative.

4.1.7 Control systems are to be arranged such that, in the event of failure of the working control system, the standby system takes control automatically without manual intervention and without any adverse effect of the ship's station keeping performance.

4.1.8 At least three position reference systems incorporating at least two different measurement techniques provided and are to be arranged so that a failure in one system will not render the other systems inoperative.

4.1.9 At least three heading reference sensors are to be provided and arranged so that a failure of one sensor will not render the other sensor(s) inoperative.

4.1.10 The DP system is to incorporate a computer based consequence analysis to determine whether the position of the vessel would remain within the limits set by the operator in the event of a worst case fault. An audible and visual alarm is to be initiated where the consequence analysis determines that the limits would be exceeded. Where applicable to the timescale for safely terminating operations, the consequence analysis is to allow for manual input of predicted environmental conditions.

■ *Section 5* Class notation DP(AAA)

5.1 Requirements

5.1.1 For assignment of **DP(AAA)** notation, the applicable requirements of Sections 2, 3 and 4, together with 5.1.2 to 5.1.13 are to be complied with.

5.1.2 The DP system is to be arranged such that failure of any component or system necessary for the continuing correct functioning of the DP system, or the loss of any one compartment as a result of fire or flooding will not result in a loss of position. This is to be verified by means of an FMEA, *see* 1.3.6.

5.1.3 Thruster units are to be installed in separate machinery compartments, separated by a watertight A–60 class division.

5.1.4 Generating sets, switchboards and associated equipment are to be located in at least two compartments separated by an A–60 class division, so that at least half of the equipment will be available following a fire or similar fault in one of the compartments. If the equipment is located below the operational waterline, the division is also to be watertight. There is to be provision to connect the switchboard sections together by means of circuit breakers.

5.1.5 Duplicated cables and pipes for services essential for the correct functioning of the DP system are not to be routed through the same compartments. If this is not practicable, then they are to be carried in A–60 protected ducts. The termination arrangements are also to take due account of the degree of protection. Alternative arrangements will be considered.

5.1.6 Where duplicated cables and pipes for services essential for the correct functioning of the DP system are installed in adjacent compartments, A-60 rated fire protection is to be provided between the spaces. Details of alternative arrangements which demonstrate essential equipment located in an adjacent space will continue to operate satisfactorily and essential services will continue to be available in the event of a fire in the adjacent space may be submitted for consideration.

5.1.7 An additional/emergency automatic control unit is to be provided at an emergency control station, in a compartment separate from that for the main control station, and is to be arranged to operate independently from the working and standby control units required by 4.1.7.

5.1.8 Arrangements are to be provided such that in the event of a failure of the working and standby control units a smooth transfer of control to the emergency control unit may be effected from the emergency control station by manual means.

5.1.9 Arrangements are to be provided at the emergency control station so that changes in the resultant vectorial thrust output may be readily effected by a single operator action.

5.1.10 The control/indication unit of one of the position reference systems required by 4.1.8 is to be located at the emergency control station. A repeater control/indication unit from this system is to be located at the main control station.

5.1.11 One of the heading reference sensors required by 4.1.9 is to be located at the emergency control station.

5.1.12 One wind sensor is to directly supply the additional/emergency control unit.

5.1.13 The additional/emergency control unit is to be supplied from its own independent UPS, *see* 2.3.10.

■ *Section 6* Performance Capability Rating (PCR)

6.1 Requirements

6.1.1 For assignment of a Performance Capability Rating (PCR), a calculation will be carried out using the information specified in 1.3.7.

6.1.2 Two rating numerals are calculated:

(a) The first numeral represents the percentage of time that the ship can remain on station when subjected to a set of standard environmental conditions (North Sea fully developed) with all thrusters operating.

(b) The second numeral represents the percentage of time that the ship can remain on station when subjected to a set of standard environmental conditions (North Sea fully developed) with the most effective thruster being inoperative.

A typical rating might be (95), (70).

6.1.3 In calculating the PCR the following parameters are considered:

(a) Thruster force vectors.

(b) Thruster/thruster, thruster/hull and thruster/current interactions.

(c) Sea current loads on the ship.

(d) Wind force on the ship.

(e) Wave drift force on the ship.

6.1.4 Where the ship has been subject to alteration or addition, which may affect the performance characteristics of the DP system, the PCR is to be recalculated.

Section 7
Testing

7.1 General

7.1.1 Control units are to be surveyed at the manufacturer's works and are to be tested to the approved test schedule to the Surveyor's satisfaction, *see* 1.3.5(g).

7.1.2 Before a new installation (or any existing installation, which has been subject to alteration or addition which may affect the performance characteristics of the system) is put into service, sea trials are to be carried out to the approved schedule and to the Surveyor's satisfaction, *see* 1.3.5(g).

7.1.3 The suitability of the dynamic positioning system is to be demonstrated during sea trials, observing the following:

(a) Response of the system to simulated failures of major items of control and mechanical equipment, including loss of electrical power, verifying the findings of the FMEA where required.

(b) Response of the system under a set of predetermined manoeuvres for changing:
    (i) location of area of operation; and
    (ii) heading of the ship.

(c) Continuous operation of the system over a period of four to six hours.

7.1.4 Three copies of the dynamic positioning system sea trial test schedules, as required by 1.3.5(g), each signed by the Naval Authority, Surveyor and Builder are to be provided on completion of the survey. One copy is to be placed and retained on board the ship and the others submitted to LR and Naval Authority.

7.1.5 Records and data regarding the performance capability of the dynamic positioning system are to be maintained on board the ship and are to be made available at the time of the Annual Survey. *See* Vol 1, Pt 1, Ch 3,2.3.13.

~~Volume 3, Part 1 Chapter 4~~

~~Bridge Navigational Arrangements~~

Effective date 1 January 2011

Section 1
General requirements

1.1 General

1.1.1 The requirements of this Chapter apply to naval ships where an optional class notation for optimising the environment on the bridge for navigational tasks, including periodic operation of the ship under the supervision of a single watchkeeper on the bridge and/or integrated bridge systems, is requested, and are additional to those applicable in other Parts of the Rules.

1.1.2 The requirements of this Chapter are based on the understanding that the *International Regulations for Preventing Collisions at Sea* and all other relevant Regulations relating to Radio Communications and Safety of Navigation required by Chapters IV and V respectively of SOLAS are complied with.

1.1.3 Requirements additional to those in this Chapter may be imposed by the Naval Authority.

1.1.4 The requirements of this Chapter are framed on the understanding that contingency plans for emergencies are specified and the conditions under which one man watch is permitted are clearly defined in an operations manual which is acceptable to the Naval Authority.

1.1.5 In general, ships complying with the requirements of Sections 1 to 4 of this Chapter will be eligible for the notation **NAV1**.

1.1.6 Section 5 of this Chapter states additional requirements which apply where the navigational functions are integrated. In general, ships complying with the requirements of Section 5 will be eligible for the notation **IBS**, *see* Vol 1, Pt 1, Ch 2,3.8.4. In addition to the assessment of the navigational function integration, the assignment of the notation **IBS** requires that the layout of the bridge and the equipment located on the bridge is to the satisfaction of LR, *see* 5.2.1.

1.2 Information and plans required to be submitted

1.2.1 The following information and plans are to be submitted in triplicate:

- For programmable electronic systems, the plans required by Vol 2, Pt 9, Ch 1,1.2.5.
- Details of the intended area of operation of the ship.
- List of navigational equipment detailing manufacturer, and model and Naval Authority approval (where applicable).
- Functional block diagrams and descriptions of the navigational equipment, internal communication systems and watch safety system indicating their relationship to each other.
- Details of the electrical power supplies to the navigational equipment, internal communications systems, watch safety system and clear view arrangements.
- A general arrangement of the vessel showing the fields of vision from the bridge.
- A general arrangement of the bridge and wheelhouse showing the positions of consoles, panels, handrails, seating, windows and clear view arrangements.
- A profile view of the wheelhouse detailing the inclination of windows, heights of upper and lower edges of windows, and dimensions of consoles.
- Detailed arrangements of consoles and panels showing the layout of equipment.
- Test schedules which should include methods of testing and test facilities provided.
- A schedule of the electrical and electronic equipment referred to in 2.2.10 giving details of:
  - equipment description;
  - manufacturer;
  - type and/or model; and
  - evidence of electromagnetic compatibility.

1.3 Definitions

1.3.1 The following definitions are applicable to these Rules:

Workstation:
A position at which one or several tasks, constituting a particular activity is carried out.

Navigation workstation:
A workstation at which the navigator may carry out all tasks relevant for deciding, executing and maintaining course and speed in relation to waters and traffic. The instrumentation and controls at the navigation workstation should allow the navigator to:

- analyse the traffic situation;
- monitor position, course, track, speed, time, propeller revolutions and pitch, rudder angle, depth of water, rate of turn, and wind speed and direction;
- alter course and speed;
- effect internal and external communications;
- give and receive sound signals;
- control navigational lights;
- monitor and acknowledge navigational alarms;
- confirm his well-being and watch-keeping awareness;
- record navigational data.

Main steering position:
That part of the navigation workstation where those controls and instrumentation relevant to controlling the ship's course are located.

Conning position:
A place on the bridge which is used by navigators when commanding, manoeuvring and controlling a ship.

Voyage planning workstation:
A workstation at which the navigator may carry out the following tasks without affecting the actual navigation of the vessel:

- examine and update charts and other relevant documentation;
- plan a voyage as a series of waypoints, courses, speeds and turns;
- calculate an estimated time of arrival at various points on the voyage;
- determine and plot the ship's position.

On the bridge or in the vicinity of the bridge:
Refers to the deck and bridge zone defined in IEC 60533: *Electrical and electronic installations in ships – Electromagnetic compatibility*, that covers:

- the wheelhouse, including bridge wings;
- control rooms, characterised by equipment for inter-communication, signal processing, radio communication and navigation, auxiliary equipment; and
  area in close proximity to receiving and/or transmitting antennas and large openings in the metallic structure (equipment beyond 5 m need not be considered for this purposes).

■ *Section 2*
Physical conditions

2.1 Bridge and wheelhouse arrangement

2.1.1 The bridge configuration, arrangement of consoles and equipment location are to be such as to enable the officer of the watch to perform navigational tasks and other functions allocated to the bridge, as well as maintain an effective lookout. The following tasks are to be supported:

- navigation and manoeuvring;
- monitoring;
- manual steering;
- docking;
- planning;
- safety;
- communications; and
- conning.

2.1.2 Equipment and associated displays and indicators are to be sited at clearly defined workstations.

2.1.3 Consoles, including the chart table, are to be positioned so that the instrumentation they contain is mounted in such a manner as to face a person looking forward. As far as practicable, operating surfaces are to be normal to the operator's line of sight.

2.1.4 From other workstations within the wheelhouse it is to be possible to monitor the navigation workstation and to maintain an effective lookout.

2.1.5 The main access to the bridge is to be by means of an internal stairway. Secondary external access is also to be provided.

2.1.6 Clear passage of at least 700 mm width is to be available to allow movement around the bridge with a minimum of inconvenience. Particular attention is to be paid to the following routes which are to be as direct as possible:

(a) From bridge wing to bridge wing, a clear passage of at least 1200 mm in width.
(b) Between the internal entrance to the bridge and the route in (a) a clear passage of at least 700 mm in width is to be provided.
(c) Between adjacent workstations, a clear passage of at least 700 mm is to be provided.
(d) Between the bridge front bulkhead or any consoles and installations placed against the front bulkhead, to any consoles or installations placed away from the bridge front, a clear passage of at least 800 mm is to be provided.

Space necessary for operating at a workstation is to be considered as part of the workstation and is not to be part of the passageway.

2.1.7 The clear height between the wheelhouse deck surface covering and the underside of the deckhead is to be at least 2250 mm. The lower edge of deckhead mounted equipment is to be at least 2100 mm in open areas, passageways and at standing workstations.

2.1.8 Toilet facilities are to be provided on or adjacent to the bridge.

2.2 Environment

2.2.1 The bridge is to be free of physical hazards to personnel. There are to be no sharp edges or protuberances and wheelhouse, bridge wing and upper bridge decks are to be free of trip hazards and have non-slip surfaces whether wet or dry.

2.2.2 Sufficient hand-rails or equivalent are to be fitted inside the wheelhouse and around workstations to enable personnel to move or stand safely in bad weather. Protection of stairway openings is to be given special consideration.

2.2.3 Provision for seating is to be made in the wheelhouse. Means for securing the seating are to be provided having regard to storm conditions.

2.2.4 Glare and reflections from surfaces are to be minimised. In this respect walls, ceilings, consoles, chart tables and other major fittings are to be provided with a suitable low reflective finish. Arrangements are to be provided to prevent the obscuration of information presented on visual display units and instruments which are fitted with transparent covers.

2.2.5 Entrance doors to the wheelhouse are to be securable from the inside, and operable with one hand. Bridge wing doors are not to be self-closing, and are to be provided with means to hold them open.

2.2.6 An adequate air conditioning or mechanical ventilation system, together with sufficient heating, according to climatic conditions, is to be provided in order to maintain the temperature of the wheelhouse within the range of 14°C to 30°C and the humidity within the range 20 per cent to 60 per cent. The discharge of hot or cold air is not to be directed towards bridge personnel. Control of this system is to be provided in the wheelhouse.

2.2.7 The noise level on the bridge is not to interfere with verbal communication, mask audible alarms, or be uncomfortable to bridge personnel. In this respect the ambient noise level in the wheelhouse in good weather is not to exceed 65 dB(A).

2.2.8 A sound reception system or alternative means is to allow external sound signals to be heard and their direction determined within the wheelhouse.

2.2.9 Permanently installed electrical and electronic equipment is to be installed so that electromagnetic interference does not affect the proper function of the navigational systems and equipment. Installation of the equipment in accordance with the guidelines and recommendations included in IEC 60533: *Electrical and electronic installations in ships – Electromagnetic compatibility*, or an acceptable equivalent standard, would generally be considered to meet the requirement.

2.2.10 Permanently installed electrical and electronic equipment on the bridge or in the vicinity of the bridge that is not subject to the approval required by 3.1.13, is to have undergone electromagnetic compatibility testing that demonstrates the equipment satisfies the conducted and radiated emission requirements of:

- IEC 60533: *Electrical and electronic installations in ships – Electromagnetic compatibility*; or
- IEC 60945: *Maritime navigation and radio communication equipment and systems – General requirements – Methods of testing and required test results*.

Testing in accordance with other appropriate standards is subject to consideration and details are to be submitted.

2.2.11 To demonstrate compliance with 2.2.10, a schedule of applicable equipment is to be compiled, *see* 1.2.1. Where it is proposed to add to or modify the equipment referred to in 2.2.10 the schedule is to be maintained accordingly, *see also* 6.1.1. A copy of the schedule documentation is to be placed on board the vessel and a copy is to be made available to the LR Surveyor on request.

2.2.12 Passive electromagnetic equipment, considered not liable to cause or be susceptible to electromagnetic disturbances, may be provided with an exemption statement in place of evidence of electromagnetic compatibility for the purposes of 2.2.11. Examples of passive electromagnetic equipment include cables, purely resistive loads and batteries.

2.3 Lighting

2.3.1 The level of lighting is to enable bridge personnel to perform all bridge tasks, including maintenance and chart and office work, by day and night. Controls, indicators, instruments, keyboards, etc., on the bridge are to be capable of being seen in the dark either by means of internal lighting within the equipment or the wheelhouse lighting system. A satisfactory level of flexibility within the lighting system is to be available to enable the bridge personnel to adjust the lighting in brightness and direction as required in different areas of the bridge and by the needs of individual instruments and controls.

2.3.2 All illumination and lighting of instruments, keyboards and controls is to be adjustable down to zero, except the lighting of alarm indicators and the controls of dimmers which are to remain readable.

2.3.3 Two separate circuits are to be provided for wheelhouse lighting such that failure of any one of the circuits does not leave the space in darkness. *See* Vol 2, Pt 10, Ch 1,5.7.

2.3.4 Emergency lighting is to be provided for the wheelhouse, stairways and exits. *See* Vol 2, Pt 10, Ch 1,3.

2.3.5 Lighting used in areas and for items of equipment requiring illumination, whilst the ship is navigating, is to be such that night vision is not impaired, e.g. red lighting. Such lighting is to be arranged so that it cannot be mistaken for a navigation light by another ship and so as to prevent glare and stray image reflections.

2.3.6 In order to avoid possible confusion in colour discrimination, red lighting is not to be fitted over chart tables.

2.3.7 To avoid unnecessary light sources in the front area of the bridge, only instruments necessary for the safe navigation and manoeuvring of the ship are to be located in this area.

2.3.8 Means are to be provided to prevent the sudden flooding of light onto the bridge from alleyways, accommodation areas and the chart table area.

2.3.9 Deck and superstructure lights which may impair safe navigation are to be controlled from the bridge.

2.3.10 Each navigation light is to be provided with an audible and visual alarm to indicate failure of the light. *See* Vol 2, Pt 10, Ch 1,14.5.

2.3.11 Means are to be provided to test alarm and indicator lamps.

2.4 Windows

2.4.1 All wheelhouse windows are to be constructed of shatterproof toughened glass having a strength commensurate with the degree of exposure of the bridge to storm conditions and complying with a recognised National or International Standard, e.g. ISO 21005: 2004 *Ships and marine technology – Thermally toughened safety glass panes for windows and side scuttles.*

2.4.2 Windows are to be as wide as possible and divisions between them are to be kept to a minimum. No division is to be positioned immediately forward of any workstation or on the ship's centreline.

2.4.3 To reduce reflections from internal lighting, etc., the bridge windows are to be inclined from the vertical plane top out, at an angle of not less than 10° and not more than 25°. Alternative arrangements will be specially considered.

2.4.4 The height of the lower edge of the front windows is to allow a forward view over the bow for a person at the navigation workstation and is not to obstruct any of the required fields of vision, *see* 2.5. In this respect the height of the lower edge of the front windows above the deck is to be kept as low as possible and, as far as practicable, is not to be more than 1000 mm above the deck surface.

2.4.5 The upper edge of the front windows is to allow a forward view of the horizon for a person with an eyeheight of 1800 mm at the conning position when the ship is pitching in heavy seas and, as far as practicable, is not to be less than 2000 mm above the deck surface.

2.4.6 Clear views through the windows in front of the conning position, navigation workstation and, where applicable, bridge wings are to be provided at all times regardless of weather conditions. At least two windows are to provide such a view.

2.4.7 To ensure a clear view in bright sunshine, sun-screens with minimum colour distortion are to be provided. Such screens are to be readily removable and not permanently installed. Polarised and tinted windows are not to be fitted.

2.4.8 Heavy duty wipers, preferably provided with an interval function and a fresh water wash, are to be fitted.

2.4.9 Efficient cleaning, de-icing and de-misting systems are to be fitted.

2.4.10 Suitable safe external access arrangements fitted under the bridge windows are to be provided to enable cleaning and maintenance in the event of failure of the above systems.

2.5 Fields of vision

2.5.1 It is to be possible to observe all objects necessary for navigation, including other traffic and navigation marks, in any direction from inside the wheelhouse. In this respect there is to be a field of view around the vessel of 360º obtained by an observer moving within the confines of the wheelhouse.

2.5.2 The view of the sea surface from the conning position and the navigation workstation is not to be obscured by more than two ship lengths, or 500 m, whichever is less, forward of the bow to 10º on either side irrespective of the ship's draught and trim.

2.5.3 Blind sectors caused by obstructions outside of the wheelhouse forward of the beam obstructing the view of the sea surface as seen from the conning position and the navigation workstation are not to exceed 10° each. The total arc of blind sectors is not to exceed 20° and the clear sector between blind sectors shall be at least 5°. However, in the view described in the preceding paragraph each individual blind sector is not to exceed 5º.

2.5.4 The horizontal field of vision from the conning position and the navigation workstation is to extend over an arc from more than 22,5º abaft the beam on one side, through forward, to more than 22,5º abaft the beam on the other side. *See* Fig. 4.2.1.

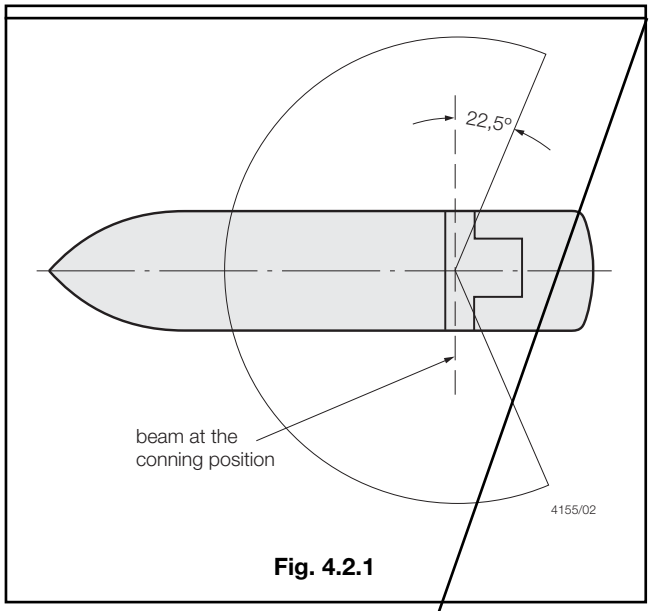

Fig. 4.2.1

2.5.4 The horizontal field of vision from the conning position and the navigation workstation is to extend over an arc from more than 22,5º abaft the beam on one side, through forward, to more than 22,5º abaft the beam on the other side. *See* Fig. 4.2.1.

2.5.5 From the main steering position the field of vision is to extend over an arc from dead ahead to at least 60° on each side. *See* Fig. 4.2.2.

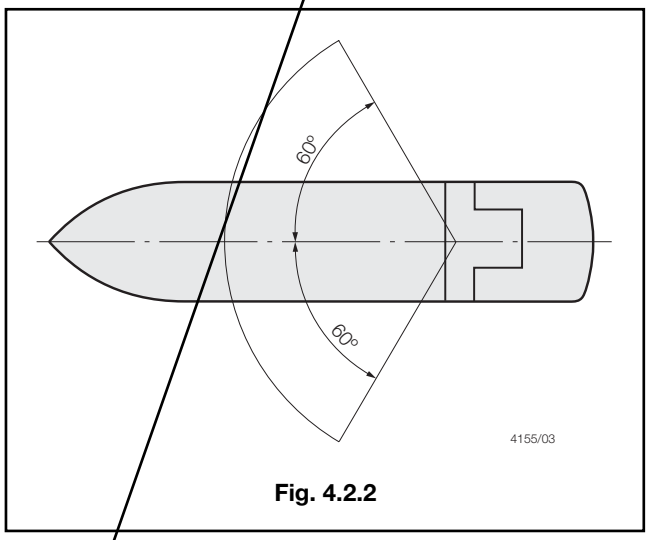

Fig. 4.2.2

2.5.6 From each bridge wing the field of vision is to extend over an arc from at least 45º on the opposite bow through dead ahead and then aft to 180º from dead ahead. *See* Fig. 4.2.3.

2.5.7 There is to be a line of sight from the port wing to the starboard wing through the wheelhouse.

2.5.8 The ship's side is to be visible from the bridge wing.

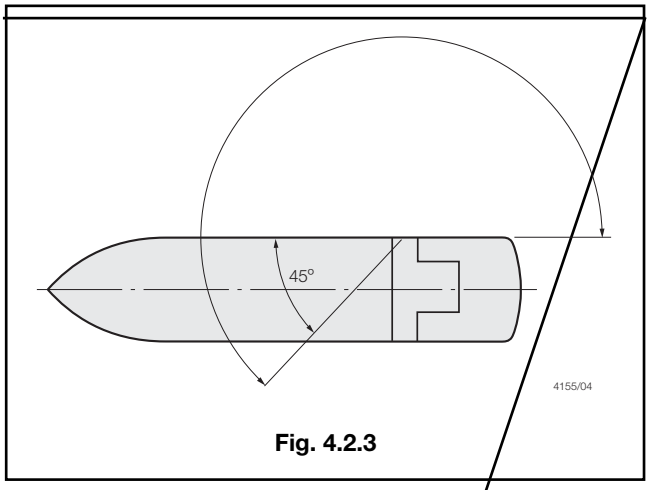

Fig. 4.2.3

2.5.9 From workstations for functions other than navigation the field of vision is to enable an effective lookout to be maintained and in this respect is to extend at least over an arc from 90° on the port bow, through forward, to 22,5° abaft the beam on the starboard side. *See* Fig. 4.2.4.

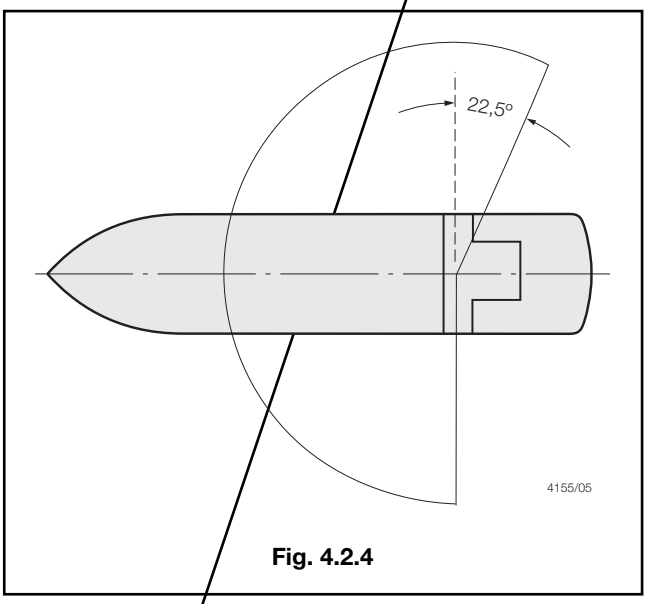

Fig. 4.2.4

2.5.10 The height of consoles is not to interfere with the fields of vision defined above and is not to exceed 1350 mm.

■ *Section 3*
Workstations

3.1 Navigation workstation

3.1.1 A workstation for navigation is to be arranged to enable efficient operation by one person under normal operating conditions. The workstation area is to be sufficient to allow at least two operators to use the equipment simultaneously. The arrangement of instruments and controls are to allow the use of all instruments and controls necessary for navigating and manoeuvring in any normal working position.

3.1.2 An adequate conning position is to be provided close to the forward centre window. If the view in the centreline is obstructed by large masts, cranes, etc., two additional conning positions giving a clear view ahead are to be provided, one on the port side and one on the starboard side of the centreline, no more than 5 m apart. In addition to the conning position, a second position with a view of the area immediately in front of the bridge superstructure is to be provided close to a forward window or, alternatively, the conning position is to be wide enough to accommodate two persons.

3.1.3 The main steering position is to be located on the ship's centreline unless the view ahead is obstructed by large masts, equipment, etc. In this case the steering position is to be located a distance to starboard of the centreline sufficient to obtain a clear view ahead and special steering references for use by day and night are to be provided, e.g. sighting marks forward.

3.1.4 The following facilities are to be provided at the navigation workstation:

- Radar and radar plotting facilities, *see* 3.1.5;
- position fixing system displays, *see* 3.1.6;
- echo sounder display;
- speed and distance indications, *see* 3.1.11 and 3.1.12;
- gyro compass display, *see* 3.1.7;
- magnetic compass display;
- wind speed and direction indication;
- steering controls and indication, *see* Vol 2, Pt 6, Ch 1,7;
- rate of turn indication;
- course/track controls and indications, *see* 3.1.8 to 3.1.10;
- main propulsion and thruster controls and indication, *see* Vol 2, Pt 9, Ch 1,2.6;
- watch safety system acknowledge;
- watch safety system manual initiation;
- internal communications system;
- VHF radiotelephone;
- time indication;
- window clear view controls;
- navigation lights controls;
- whistle control;
- morse light keys;
- wheelhouse/equipment lighting controls;
- automatic ship identification system (AIS) information;
- sound reception system where fitted, *see* 2.2.8.
- means to cease the distribution of long-range identification and tracking information, where arrangements in accordance with SOLAS Ch V, Reg.19-1,7 are installed.

3.1.5 Two functionally independent radars or alternative means are to be provided to determine and display the range and bearing of radar transponders and other surface craft, obstructions, buoys, shorelines and navigational marks. One of the radars is to operate in the X-band (9 GHz) and the other is to operate in the S-band (3 GHz). Both radars are to include automatic plotting aids to determine collision risks, and at least one radar is to be equipped with an automatic radar plotting aid (ARPA), capable of tracking at least 20 targets, while the other is to be either ARPA or an automatic tracking aid (ATA).

3.1.6 At least two different automatic position fixing systems giving a continuous display of latitude and longitude are to be provided. One of these is to be GPS or equivalent,

the other is to be Decca and/or Loran C depending on the area of operation.

3.1.7 A gyrocompass or alternative means for determining by shipborne, non-magnetic means, displaying and transmitting the ship's heading is to be provided and is to be clearly readable by the helmsman at the main steering position. The heading information is to be used directly by the radars, radar plotting aids and automatic identification system, *see* 3.1.5 and 3.1.13. The gyrocompass is to be provided with a gyrocompass heading repeater located at the emergency steering position in the steering gear compartment and a gyrocompass bearing repeater allowing bearings to be taken over 360°.

3.1.8 An autopilot, track control system or alternative means of automatically maintaining the ship's heading or a straight track is to be provided. At any time, it is to be possible to immediately restore manual control. The arrangements for restoring manual control are to be such that inadvertent operation is prevented.

3.1.9 Heading monitoring is to be provided to monitor the actual heading information by independent heading sources. An off-course warning is to be given if the actual heading of the ship deviates from the set track course beyond a pre-set value. The pre-set off-course warning limit is to be large enough to prevent unnecessary alarms.

3.1.10 Where automatic track following is provided, sufficient warning is to be given of the approach of a waypoint, so that, in the event of no acknowledgement from the officer of the watch, there is adequate time for the back-up navigator to reach the bridge and accept the change of course.

3.1.11 A speed log or alternative means of indicating the ship's speed and distance through water is to be provided. The speed through water measurement is to be used directly by the ARPA as an aid to collision avoidance.

3.1.12 A speed log or alternative means of indicating the ship's speed and distance over ground is to be provided. Speed over ground is to be indicated in both the fore-aft and athwartships directions.

3.1.13 Navigational systems and equipment are to be of a type approved by the naval authority and in conformity with appropriate performance standards not inferior to those adopted by IMO from time to time. Documentary evidence to this effect is to be submitted.

3.1.14 Where alternative means of fulfilling the navigational requirements are permitted, the means are to be approved by the Naval Authority and in conformity with appropriate performance standards.

3.2 Voyage planning workstation

3.2.1 A voyage planning workstation is to be provided at which the following facilities are available:

- chart table with instruments;
- position fixing systems;
- time indication.

3.2.2 Time indication at the voyage planning workstation is to be derived from the same system as used at the navigation workstation.

3.2.3 The chart table is to be large enough to accommodate all chart sizes normally used internationally for maritime traffic and is to have facilities for illuminating the chart, *see also* 2.3.8.

■ *Section 4* Systems

4.1 Alarm and warning systems

4.1.1 Alarms associated with navigation equipment are to be both audible and visual and are to be centralised for efficient identification. Repeater displays may be fitted on the bridge wings and at other appropriate positions on the bridge where necessary.

4.1.2 The following alarms are to be provided:

- closest point of approach;
- shallow depth;
- waypoint approaching (where automatic track following is provided);
- off-course;
- off-track (where automatic track following is provided);
- steering alarms, *see* Table 1.8.1 in Vol 2, Pt 6, Ch 1 or Table 2.6.1 in Vol 2, Pt 4, Ch 3 as applicable;
- navigation light failure;
- gyro compass failure;
- watch safety system failure;
- failure of any power supply to the distribution panels referred to in 4.4.1.

4.1.3 Audible signals are to be designed not to startle operators. Suitable types are shown in Table 4.4.1.

Table 4.4.1 Suitable audible signals

Type	Typical characteristics	Considerations
Buzzer	Low intensity and frequencies	Good alerting in quiet environment without startling
Bell	Moderate intensity and frequencies	Penetrates low frequency noise well, abrupt onset has a high alert value
Chime	Moderate intensity and frequencies	Good in quiet environment, non startling
Tone	Moderate intensity and limited frequency range	Convenient for intercom transmission, high alert value if intermittent

4.2 Watch safety system

4.2.1 A watch safety system satisfying the requirements of the IMO performance standards for a bridge navigational watch alarm system (BNWAS) and approved by the Naval Authority is to be provided to monitor the well-being and awareness of the watchkeeper. The system is not to cause undue interference with the performance of bridge functions.

4.2.2 The watch safety system is to automatically become operational whenever the ship's heading or track control system is activated.

4.2.3 The system is to be such that at a predetermined time the watchkeeper receives warning that he must indicate his well-being by accepting the warning.

4.2.4 The time interval between warnings is to be adjustable up to a maximum of 12 minutes.

4.2.5 It is to be possible to acknowledge the warning at the navigation workstation and at other appropriate locations on the bridge where an effective look-out may be kept. Acknowledgement of any alarm is automatically to reset the time interval between warnings. Manual adjustment of controls may also be used for this purpose.

4.2.6 Visual warning indications are to be visible, and audible warning indications are to be audible, from all operational positions on the bridge where the watchkeeper may reasonably be expected to be stationed. The colour of visual indicators is not to impair night vision.

4.2.7 In the event that the watchkeeper fails to respond and accept the warning or if any alarm has not been acknowledged on the bridge within a period of 30 seconds, the system is to immediately initiate a watch alarm to warn the Commanding Officer and the appointed back-up navigator through a fixed installation.

4.2.8 In the event that the watch alarm is not acknowledged, the system is to initiate the watch alarm at the locations of further crew members capable of taking corrective actions following a time delay sufficient to allow the Commanding Officer or backup navigator to reach the bridge. The time interval is to be adjustable between 90 seconds up to a maximum of 3 minutes. The watch alarm to warn the further crew members may be initiated at the same time as the watch alarm to warn the Commanding Officer and backup navigator.

4.2.9 The watch alarms which sound in the locations of the Commanding Officer, officers and further crew members capable of taking corrective action should be easily identifiable by its sound and should indicate urgency. The volume of this alarm should be sufficient for it to be heard throughout the locations above and to wake sleeping persons.

4.2.10 Manual initiation of the watch alarm from the bridge is to be possible at any time.

4.2.11 The system is to be designed and arranged such that only the ship's Commanding Officer has access for enabling and disabling it and setting the appropriate intervals, so as to prevent accidental or unauthorised operation, e.g. removing the fuses or keeping the acknowledgement button permanently depressed either accidentally or deliberately.

4.2.12 The fixed installation is to be connected to the Commanding Officer's and Navigating Officers' cabins, offices, mess and public rooms.

4.2.13 Acknowledgement of the watch alarm is only to be possible on the bridge.

4.2.14 If, depending upon the shipboard work organisation, the back-up navigator may attend locations not connected to the alarm transfer system, a wireless portable device is to be provided enabling both the transfer of alarms and two way speech communication with the bridge. An audible warning from the portable device is to be provided in the event of loss of the wireless link with the bridge. Alternative arrangements will be considered.

4.2.15 Failure of the watch alarm system is to activate an audible and visual alarm at the centralised alarm system.

4.3 Telephone system

4.3.1 A telephone system is to be provided to enable two way speech communication between the wheelhouse and at least the following locations:

- machinery control station space; *see* Vol 2, Pt 9, Ch 1,2.6.8;
- emergency steering position in the steering gear compartment;
- Commanding Officer's and Navigating Officers' cabins, offices, mess and public rooms.

4.3.2 The bridge is to have priority over the system.

4.3.3 A list of extension numbers is to be clearly displayed adjacent to each telephone.

4.4 Power supplies

4.4.1 Local distribution panels are to be provided for all items of electrically operated navigational equipment, the telephone system, the watch safety system and the clear view systems. These panels are to be supplied by two exclusive circuits, one fed from the main source of electrical power and one fed from an emergency source of electrical power. Each item of equipment is to be individually connected to its distribution panel. The power supplies to the distribution panels are to be arranged with automatic changeover facilities between the two sources. Failure of any power supply to the distribution panels is to initiate an audible and visual alarm. This alarm should be included in the ship's alarm system as required by Vol 2, Pt 9, Ch 1,3.2, where applicable.

4.4.2 The watch safety system and the telephone system are to remain operational during blackout conditions.

4.4.3 Following a loss of power which has lasted for 45 seconds or less, all navigation functions are to be readily re-instated. In this respect, all navigational equipment is to recover within five minutes, with minimum operator intervention, by virtue of the emergency source and, where necessary, an uninterruptible power source.

■ *Section 5*
Integrated Bridge Navigation Systems – IBS notation

5.1 General

5.1.1 Where it is proposed that the bridge navigation functions are so arranged as to form an integrated bridge system, the requirements of 5.2 to 5.6 are to be complied with.

5.2 General requirements

5.2.1 For assignment of the notation **IBS**, in addition to satisfying the other requirements of this Section:

(a) the layout of the bridge and the equipment located on the bridge is to satisfy the requirements of a relevant Naval, International or National ergonomic or human-centred design standard or an acceptable equivalent; or

(b) the notation **NAV1** is also to be assigned and the layout of the bridge and the equipment on the bridge are to satisfy the requirements of Sections 1 to 4; or

(c) where the bridge is not intended to operate a periodic one man watch, the layout of the bridge and the equipment on the bridge are to satisfy the requirements of Sections 1 to 4, with the exception that the requirements of 4.2 and 4.3 may be relaxed.

5.2.2 Where 5.2.1(a) is applicable, the submissions required by 1.2.1 are to include evidence demonstrating satisfaction of the requirements of an identified relevant standard.

5.2.3 To satisfy 5.2.2, the evidence submitted is to:

(a) include identification of testing necessary to verify compliance with the submitted test schedules for assessment by LR; or

(b) include relevant documentation demonstrating compliance with the relevant identified standard to the satisfaction of the Naval Authority. Such documentation is to be submitted prior to the assignment of the **IBS** notation. This may necessitate co-ordination of classification and Naval Authority Surveys, particularly for new construction, before the **IBS** notation may be assigned.

5.2.4 Where 5.2.1(c) is applicable, the submissions required by 1.2.1 are to include plans and information for the consideration of LR which demonstrate that the applicable requirements of Sections 1 to 4 have been satisfied.

5.2.5 The design features for computer hardware, local area networks and software required by Vol 2, Pt 9, Ch 1,2.10, 2.11, 2.12 and 2.13 respectively are to be complied with. Alarms associated with hardware and data communication are to be incorporated in the centralised alarm system required by 4.1.

5.2.6 Failure of a part of the integrated bridge navigation system is not to affect other parts except for those that directly depend upon the information from the defective part. Following such a failure, it is to be possible to operate each other part of the system separately.

5.3 Equipment

5.3.1 Two independent gyro compasses are to be available to provide heading information to the system. The heading signal from each gyro compass is to be continuously available for display and for providing input to all relevant items of navigational equipment.

5.3.2 Only one gyro compass is to be used by the integrated bridge system at any time for main display and control purposes. The navigating officer is to be able to switch between compasses at any time. The non-selected compass is to be used automatically as the independent heading source for the off-course warning required by 3.1.9.

5.3.3 It is to be possible to compare readings from each gyro compass via the navigation workstation displays.

5.3.4 Automatic comparison between the gyro compasses is to be provided and an alarm given if the difference between heading signals exceeds a pre-set value.

5.3.5 The capability to receive and utilise differential GPS corrections (or an equivalent) is to be included in the integrated bridge system.

5.3.6 As a minimum, the following information is to be displayed at the navigation workstation via visual display units:

- steering mode;
- gyro heading;
- course to steer;
- rate of turn;
- rate of turn order;
- speed and distance (from log and from GPS);
- speed order;
- waypoint bearing, distance and ETA;
- water depth and alarm setpoint;
- position fix from each available system;
- main propulsion and thruster indication, *see* Vol 2, Pt 9, Ch 1,2.6;
- steering indication, *see* Vol 2, Pt 6, Ch 1,7;
- wind speed and direction;
- time, *see* 3.2.2.

5.3.7 Additional information such as machinery monitoring, fire detection, etc., may also be provided via additional pages on the visual display units.

5.3.8 The centralised alarm system and the watch safety system required by 4.1 and 4.2 respectively are to be incorporated as functions of the integrated bridge system and are to be presented to the navigating officer via the conning display. The presentation and display of alarms is not to mask, obscure or degrade essential information displayed to aid navigational functions and maintain awareness of the navigational information, *see also* 5.5.

5.3.9 A route planning capability is to be provided by the integrated bridge system. This is to allow a voyage to be pre-planned as a series of waypoints and turn radii. It is to be possible to edit a voyage plan at any time without affecting route control and monitoring.

5.3.10 An automatic track following capability is to be provided in conjunction with the pre-planned route. The position fix used by the system is to be based at least upon GPS or equivalent, and is to be cross-checked by dead-reckoning based upon speed over ground provided by the ship's log. In areas where differential corrections are available it is to be possible to utilise these in the track following system.

5.3.11 In the event of failure of the track following capability, the current heading or rate of turn is to be maintained until manually altered by the navigating officer or officer in charge of the watch. The quality of position fix input to the system is to be monitored, *see also* 3.1.10 and 4.1.2.

5.3.12 The integrated bridge system is to incorporate an electronic chart display which combines simultaneously a high resolution colour representation of a nautical chart with a continuously updated record of own ship's position, pre-planned track, and radar targets in the vicinity. The entire tactical situation is to be displayed for the navigating officer in such a way that any risk from approaching, overtaking or crossing vessels may be assessed. Factors affecting the vessel's freedom to manoeuvre, such as water depths, channel boundaries, separation zones and other traffic are to be shown on the display.

5.3.13 The following alarms are to be provided and included in the centralised alarm system specified by 4.1.1:

- off-track;
- waypoint approaching, *see* 3.1.10;
- position fix inaccurate/lost;
- loss of heading input;
- loss of log input;
- equipment or sub-system failure;
- gyro mis-match.

5.3.14 Manual adjustment of any of the facilities of the integrated bridge system is to reset automatically the watch safety interval timer.

5.4 Navigation workstation

5.4.1 Integrated display and control functions are to adopt a consistent man-machine interface philosophy and strategy. Particular consideration is to be paid to symbols, colours, controls, and information priorities.

5.4.2 The size, colour and density of text and graphic information displayed on a visual display unit is to be such that it may be read easily from the normal operator position under all operational lighting conditions.

5.4.3 Means are to be provided for the manual adjustment of the brightness of each visual display unit.

5.4.4 All information is to be presented on a background of high contrast, emitting as little light as possible by night.

5.4.5 Paged displays are to be presented in a way which allows the operator to quickly find the information needed. An overview page is to be easily available to remind the operator of the paging system.

5.4.6 Pages are to have a standardised format. Particular types of information and functional areas should be presented in a consistent manner, e.g. in the same position on different pages.

5.4.7 Each page is to have a unique identifying label on the screen.

5.4.8 Keyboards are to be divided logically into areas enabling rapid access to a desired function. Alphanumeric, paging and specific system keys are to be grouped separately and grouping is to be identical at all operator interfaces.

5.4.9 Soft keys may be used for display control and operation of systems non-critical to the safe operation of the vessel, otherwise dedicated controls are to be used.

5.4.10 Functions requested by the operator are to be acknowledged and confirmed by the system on completion.

5.4.11 Default values, where applicable, are to be indicated by the system when requesting operator input.

5.4.12 If an input error is detected by the system it is to allow the operator to correct the error immediately.

5.4.13 The system is to require confirmation from the operator for critical actions, e.g., they should not rely on single keystrokes.

5.4.14 Input error messages are to guide the correct responses, e.g.:

use Invalid entry: re-enter set point between 0 and 10

not Invalid entry.

5.4.15 All functions of the integrated bridge system are to remain available in the event of a single failure of an operator interface. This is to be achieved through redundancy in the integrated bridge system interfaces.

5.5 Alarm management

5.5.1 All alarms provided on the bridge are to be included in the centralised alarm system required by 4.1.1.

5.5.2 In general, the alarm system is to be in accordance with Vol 2, Pt 9, Ch 1,2.3.

5.5.3 Alarm management on priority and functional levels is to be provided within the integrated bridge system, including distribution and recording of alarms, as required. Priorities are to be as follows:

(a) **Emergency alarms** – alarms which indicate that immediate danger to human life, or to the ship and its machinery exists and that immediate action must be taken.

(b) **Distress, urgency and safety alarms** – alarms which indicate that a caller is in distress or has an urgent message to transmit.

(c) **Primary alarms** – alarms which indicate a condition that requires prompt attention to prevent an emergency condition.
(d) **Secondary alarms** – all other alarms.

5.5.4 Appropriate alarm management on general and functional levels is to be provided. This includes prioritisation, distribution and recording of alarms as required.

5.5.5 Within each priority, alarms are to be arranged in groups in order to reduce the quantity of information presented to the operator. More detailed information on the group alarm is to be readily available from the integrated bridge system on request.

5.5.6 Group alarms may be arranged on the bridge to indicate machinery faults, but alarms associated with faults requiring speed or power reduction or the automatic shutdown of propulsion machinery are to be identified by separate group alarms or by individual alarm parameters.

5.5.7 The following alarms are not to be grouped:
- Emergency alarms;
- Seperate group alarms associated with faults requiring speed or power reduction or the automatic shutdown of propulsion machinery;
- Steering gear alarms.

5.5.8 Alarms are to be displayed in order of priority. Within the priorities alarms are to be displayed in the order in which they occur. The visual display units are to provide immediate display of new alarm information regardless of the information display page currently selected. This may be achieved by provision of a dedicated alarm monitor, a dedicated area of screen for alarms or other suitable means.

5.5.9 Unacknowledged alarms are to be distinguished by either flashing text or a flashing marker adjacent to the text, and not merely by a change of colour. Acknowledged alarms are to be distinguished by either steady illuminated text or a steady illuminated marker adjacent to the text.

5.6 Power supplies

5.6.1 All equipment forming part of the integrated bridge navigation system is to be regarded as navigational equipment and as such is to have power supplies in accordance with 4.4.

■ *Section 6*
Integrated Bridge Navigation Systems – IBS Notation

6.1 General

6.1.1 Before a new installation (or any alteration or addition to an existing installation) is put into service, tests are to be carried out to ensure satisfactory operation of the navigational equipment. These tests are in addition to any acceptance tests which may have been carried out at the manufacturers' works and are based on the approved test schedule as required by 1.2.1.

6.1.2 For **IBS** Notation, testing at the manufacturer's works and trials on board are to be carried out that cover the individual components and their interaction and the bridge functions and their integration to form the Integrated Bridge System.

6.1.3 Three copies of the test schedule, signed by the Naval Authority, Surveyor and Builder are to be provided on completion of the survey. One copy is to be placed on board the vessel and the others submitted to LR and the Naval Authority.

6.1.4 Acceptance tests and trials for Programmable Electronic Systems are to include verification of software lifecycle activities appropriate to the stage in the system's lifecycle at the time of system examination.

Volume 3, Part 1 Chapter ~~5~~ 3
Propulsion and Steering Machinery Redundancy

Existing Chapter 5 *is to be renumbered* Chapter 3.

Volume 3, Part 1 Chapter ~~6~~ 4
Manoeuvring Assessment

Existing Chapter 6 *is to be renumbered* Chapter 4.

Volume 3, Part 1 Chapter ~~7~~ 5
Replenishment at Sea (RAS) Systems

Existing Chapter 7 *is to be renumbered* Chapter 5.

Volume 3, Part 1, Chapter ~~5~~ 3
Propulsion and Steering Machinery Redundancy

Effective date 1 January 2011

■ *Section 1*
General requirements

1.1 General

1.1.2 The requirements, which are optional, cover machinery arrangements and control systems necessary for ships which have propulsion and steering systems configured such that, in the event of a single failure of a system or item of active equipment, *see* 1.1.4, the ship will retain the ability to use available installed prime mover capacity and installed propulsion systems that are unaffected by the failure. The ship is also to retain steering capability at a service speed of not less than seven knots.

1.1.4 For the purpose of this chapter, items of active equipment are those which have a defined function for operation of a propulsion or steering system, such as:

- Prime movers;
- Generators and their excitation equipment;
- Transformers and converters;
- Dynamic braking resistors;
- Harmonic filters;
- Gearing;
- Pumps;
- Valves (where power actuated);
- Fuel treatment plant;
- Coolers/heaters;
- Filters;

Piping and electrical cables connecting items of active equipment are not considered to be active.

Existing paragraphs 1.1.4 *to* 1.1.8 *are to be renumbered* 1.1.5 *to* 1.1.9.

■ *Section 2*
Failure Mode and Effects Analysis (FMEA)

2.1 General

2.1.1 A FMEA is to be carried out in accordance with 2.1.2 to 2.1.7, for the propulsion systems, electrical power supply systems and steering systems to demonstrate that a single failure in active equipment or loss of an associated subsystem, *see* 1.1.4, will not cause loss of all propulsion and/or steering capability as required by a class notation. Typical subsystems include associated control and monitoring arrangements, data communications, power supplies (electrical, hydraulic or pneumatic), fuel, lubricating, cooling, etc.

(*Part only shown*)

2.1.7 The FMEA is to establish that in the event of a single ~~component~~ failure:

■ *Section 3*
Machinery arrangements

3.1 Main propulsion machinery

3.1.1 For **PSMR**, **PSMR★**, **PMR** and **PMR★** notations, independent main propulsion systems are to be provided so that at least 50 per cent of the installed prime mover capacity and not less than 50 per cent of the installed propulsion systems will continue to be available in the event of a single failure of a system or item of active equipment, *see* 1.1.4. In the event of a single failure in equipment, the remaining system(s) is to be capable of maintaining a manoeuvring speed and, for **PSMR** and **PSMR★** notations, give adequate manoeuvring capability, *see* 1.2.4.

■ *Section 5*
Separate machinery spaces ★(star) Enhancement

5.1 General

5.1.2 The machinery arrangements, control arrangements and FMEA required by Sections 2 to 4, together with testing and trials requirements in Section 6, are to be complied with in addition to 5.2 to ~~5.7~~ 5.8.

5.7 Fire containment

5.7.1 Common boundaries separating compartments containing propulsion and/or steering machinery are to be at least 'A-30' class divisions.

5.~~7~~ 5.8 FMEA

~~5.7.1~~ 5.8.1 The FMEA required by 2.1.1 for the propulsion systems, electrical power supplies, essential services, control systems and steering arrangements is also to address the following:

(a) Fire in a machinery space or control room.
(b) Flooding of any watertight compartment which could affect propulsion or steering capability.
(c) Separation of machinery spaces.

Volume 3, Part 3, Chapter 2
Fire Protection

Effective date 1 January 2011

■ *Section 8*
Fire and by-product containment

8.1 Fire and by-product containment objective

8.1.3 Where the Separate Machinery Spaces ★ (star) Enhancement notation is selected, the requirements of Pt 1, Ch 5,5.7 are also applicable.

Cross-references

Section numbering in brackets reflects any Section renumbering necessitated by any of the Notices that update the current version of the Rules for Naval Ships.

Volume 1, Part 3, Chapter 5

4.3.2 *Reference* 8.3 *now reads* 8.7
8.2.2 *Reference* 8.3.2 *now reads* 8.7.2

Volume 1, Part 4, Chapter 1

5.1.5 *Reference* Chapter 7 *now reads* Chapter 5

Volume 2, Part 1, Chapter 2

4.20.4 *Reference* 4.20 *now reads* 4.19

Volume 2, Part 4, Chapter 8

Table 4.8.1 *Reference* 5.1.3 *now reads* 5.1.4

Volume 2, Part 7, Chapter 1

13.1.11 *Reference* 4.19 *now reads* 4.18

Volume 2, Part 7, Chapter 4

2.2.12 *Reference* 4.19 *now reads* 4.18

Volume 2, Part 10, Chapter 1

1.2.16 *Reference* 5.1.4 *now reads* 5.1.5
1.2.16 *Reference* 5.1.6 *now reads* 5.1.7
1.4.6 *Reference* 14.5.4 *now reads* 14.5.5
1.4.6 *Reference* 14.5.5 *now reads* 14.5.6
1.5.4 *Reference* 5.1.3 *now reads* 5.1.4
1.11.7 *Reference* 10.14 *now reads* 10.15
1.12.4 *Reference* 13.8.3 *now reads* 13.9.3
1.14.3 *Reference* 1.15 *now reads* 1.16
1.14.4 *Reference* 1.15 *now reads* 1.16
1.15.2 *Reference* 1.15.1 *now reads* 1.16.1
1.15.2(f) *Reference* 1.15.1 *now reads* 1.16.1
1.15.4 *Reference* 1.15.1 *now reads* 1.16.1
1.18.2 *Reference* 1.18.1 *now reads* 1.19.1
10.1.1 *Reference* 10.16 *now reads* 10.17
10.8.21 *Reference* 10.13 *now reads* 10.14
10.16.1 *Reference* 10.16.2 *now reads* 10.17.2
13.4.2(e) *Reference* 13.4.2(a) *now reads* 13.5.2(a)
13.4.3(a) *Reference* 13.4.2(a) *now reads* 13.5.2(a)
13.4.3(a) *Reference* 13.4.2(b) *now reads* 13.5.2(b)
13.4.3(a) *Reference* 13.4.2(c) *now reads* 13.5.2(c)
13.4.3(b) *Reference* 13.4.2(a) *now reads* 13.5.2(a)
13.4.3(c) *Reference* 13.4.2(b) *now reads* 13.5.2(b)
13.4.3(c) *Reference* 13.4.2(d) *now reads* 13.5.2(d)
13.4.3(e) *Reference* 13.4.2(b) *now reads* 13.5.2(b)
13.4.3(e) *Reference* 13.6 *now reads* 13.7
13.4.3(f) *Reference* 13.4.2(b) *now reads* 13.5.2(b)
13.4.3(g) *Reference* 13.4.2(d) *now reads* 13.5.2(d)
13.4.3(h) *Reference* 13.4.2(d) *now reads* 13.5.2(d)
13.4.3(h) *Reference* 13.4.3(e) *now reads* 13.5.3(e)
13.4.3(j) *Reference* 13.4.2(a) *now reads* 13.5.2(a)
13.6.1 *Reference* 13.4.3(c) *now reads* 13.5.3(c)
13.6.1 *Reference* 13.4.3(d) *now reads* 13.5.3(d)
13.7.1 *Reference* 13.4.3(c) *now reads* 13.5.3(c)

Volume 2, Part 11, Chapter 2

1.2.5 *Reference* 13.9 *now reads* 13.10

Volume 3, Part 1, Chapter 5

1.1.18 *Reference* 1.1.7 *now reads* 1.1.8

Volume 3, Part 1, Chapter 7

6.1.8 *Reference* 4.19 *now reads* 4.18
7.2.1 *Reference* Chapter 5 *now reads* Chapter 3
7.2.2 *Reference* Chapter 5 *now reads* Chapter 3
7.3.1 *Reference* Chapter 6 *now reads* Chapter 4
9.1.12 *Reference* 4.19 *now reads* 4.18

Published by Lloyd's Register
Registered office
71 Fenchurch Street, London, EC3M 4BS
United Kingdom